THE

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LUNACY RAMPANT.

ATTENTION has been particularly drawn to the effect of tea-drinking on health by the Special Report of the Royal Commissioners in Lunacy for Ireland, which was laid before Parliament during the current Session, and in which a large majority of the Commissioners—all medical men of repute—upheld the opinion that the large increase of lunacy in Ireland was directly attributable to the immoderate drinking of strong tea which prevails among the Irish peasantry. Now we are threatened from abroad with a method of transferring lunacy, if the paragraphs in last week's newspapers are correctly reported, for we read that some "very wonderful "experiments, which have just been concluded by Dr. Luys, "whose observations and discoveries in connection with mag-"netism and electricity in relation to hypnotism made a "profound impression upon the scientific world some time ago, "have led to a remarkable result. The latest discovery establishes "the fact that cerebral activity can be transferred to a crown "of magnetised iron, in which the activity can be retained and "subsequently passed on to a second person. Incredible as "this may seem, Dr. Luys has proved its possibility by the "experiment just referred to. He placed the crown, which "in reality is only a circular band of magnetised iron, on the "head of a female patient suffering from melancholia with a "mania for self-destruction, and with such success was the "experiment attended that within a fortnight the patient could "be allowed to go free without danger, the crown having "absorbed all her marked tendencies. About two weeks after-"wards he put the same crown, which meanwhile had been "carefully kept free from contact with anything else, on the "head of a male patient suffering from hysteria, complicated "by frequent recurrent periods of lethargy. The patient was "then hypnotised, and immediately comported himself after "the manner of the woman who had previously worn the "crown. Indeed, he practically assumed her personality, and "spoke of himself as a woman, and uttered exactly the same "complaints as she had done. Similar phenomena have, it is "reported, been observed in the case of every patient experi-"mented upon. Another experiment showed that the crown "retained the impression acquired until it was made red-hot." The vendors of bogus *galvanic* appliances have had a bad time recently in this country, and it certainly is not the fault of the technical press if the scotched snake still retains signs of vitality and dies hard. But this magnetic transference of lunacy nonsense should be checked at once and its real character made clear, or magnetism will be answerable, in the hands of charlatans, for more mischief-working than the mild galvanic current.

To begin with we must confess our ignorance of the profound impression which Dr. Luys is credited with producing upon the scientific world, unless this world is confined to those who study the effects of hypnotism or hypnotic sug-

gestion, by means of which Dr. Luys remarkable results can be readily explained.

That cerebral activity can be transferred to a crown of magnetised iron (why not steel for preference) and there retained, scarcely requires comment from those who still retain their sanity. There are soft heads and soft-iron, hard heads and cast-iron, and the former seem to take leave of what little sense they were born with as readily as soft-iron loses the magnetism with which one tries to invest it. But the fatal drawback to the belief that magnetism had anything to do with the phenomena observed in the hysterical male patient, is in the mere fact that the man was hypnotised; everything that happened can be directly traced to this cause alone.

We do not know Dr. Luys, and therefore we are unable to state whether he is honest in his convictions, but it seems scarcely credible in the face of experiments made in this country, in France, and in America by Mr. Edison and Mr. Kennelly, that the doctor attributes his results to magnetism, which has been fully demonstrated to be devoid of all effect upon the human frame, the head being especially the part operated upon both by Mr. Kapp in England, and the before-mentioned scientists and electricians in the States.

None of the results are inconsistent with what is well recognised as the influence of the mind over the body, and they occur mostly in women and in persons of a hysterical temperament.

About 16 years ago an article appeared in *Brain* bearing upon the subject of "suggestion," from the pen of Dr. A. Hughes Bennett, physician to the hospital for epilepsy and paralysis, and assistant physician to the Westminster Hospital. In this paper Mr. Bennett speaks of the scientific investigations, in 1848, of M. Burq, whose method of procedure was first by small discs to ascertain the metal which had some influence on the patient, and then to envelop him in a sort of armour of the same substance. This cuirass was kept on for days, weeks, or months, until the beneficial changes were considered complete. With Mr. Hughes the question arose: Are the phenomena induced really due to any special virtue in the metal, as is alleged? To solve this problem he applied discs of wood, and produced thereby all the phenomena described as following the application of the metals, and he concluded that time and scientific investigation have always proved the cures which are said to be due to electricity or magnetism in the metals applied to the body, to be merely subjective phenomena, and his own observations certainly supported this view.

Immediately connected with the phenomena of magnetic sensibility in hysteria—and here we may say that bits of wood shaped and coloured to represent magnets have in many cases been used as effectually as the real article—are the facts described years ago by Prof. Charcot (see *Gazette des Hôpitaux*, No. 135), and the phenomena of transference was fully dealt with in the *Rapport fait à la Société de Biologie*, published in 1876.

There is nothing fresh in the phenomena reported in such sensational terms; the application of magnets produces these phenomena, as the result of suggestion, only in cases where such a predisposition is present, and as magnetism is not at all necessary to bring about the transference, the employment of the crown of magnetised iron seems to us to have been quite superfluous.

The idea of a magnetised head gear absorbing and retaining for any length of time the peculiarities of the brain which it has encircled, might be, to many a nervous person, of dread import. Fancy some of the mad-brained ideas of Keely, of motor fame, being surreptiously transferred to Mr. Hiram Maxim, or the "political activity" of Mr. Gladstone bottled up in a circlet of iron and placed by stealth upon the hard-headed Marquis of Salisbury!

Luckily for the community at large, this transference of cerebral activity disappears when the patient is freed from the hypnotic suggestion, so that all fears on this score, that the lunatics with which all countries abound are likely to be largely increased, may be dismissed once and for all. Moreover, the magnetism may be removed, and with it the condensed mental disorder, by subjecting the crown to a red heat.

What a tempting theme this for a paraphrase on Tyndall's "Heat—a Mode of Motion"! Only one writer could do the subject absolute justice—his very name suggests it—but out of consideration for the contemporary whose weekly pages he so brilliantly illumines, we refrain from disclosing his identity.

THE PROPOSED PACIFIC CABLE.

The long projected Pacific Cable may now we hope be looked upon as almost an accomplished fact. The only real difficulties to be overcome in the matter were financial ones. Uninitiated wiseacres have, of course, pointed out in their supreme wisdom this and that engineering difficulty, and skilled engineers themselves have had as usual to write elaborately about the subject in the form of reports, showing how this and that obstacle can be overcome in order that the ever suspicious public may have their apprehensions allayed. As a matter of fact, ever since the success of the early Atlantic cables the construction and laying of long ocean lines has been as great a matter of certainty as fitting up an electric bell. No skilled submarine cable engineer would for a moment entertain the thought that the construction of a Pacific cable was a matter of unusual difficulty; he would look upon it as a splendid thing to carry out, and would take every care that the work was thoroughly well done.

We are far from suggesting, however, that the highest skill is not required in carrying out such work, the very fact that the construction and laying of a long submarine cable is now a matter that excites but comparatively little public attention, is due to the fact that an enormous amount of detail has been most carefully studied, and vast experience gained thereby. Unremittent watchfulness and the careful, indeed elaborate, testing of every mile of core and completed cable renders the non-detection of a fault well nigh impossible. Indeed, so seldom do faults now occur that we have more than once heard the remark made, "is all this elaborate testing really necessary?" We unhesitatingly say—yes. The risk of a fault being passed over, and the heavy expense which it may involve, is more than a justification of the so-called elaborations. Electric light engineers have not unfrequently found to their cost what putting up an installation without proper testing means. As we have often

pointed out, the benefit derived by long training in a cable factory and a thorough knowledge of the elaborate testing is immense. Returning from our digression, the Pacific Cable will be, of course, the largest work of the kind yet undertaken, and immense efforts will be made by the large contractors to secure the whole or part of the work. Seeing that the whole matter has long been in contemplation, it is, doubtless, a fact that the work of preparing estimates will not be a long one, as they have, we feel sure, been long in existence in anticipation of the announcement which has at last come.

In the reports, &c., which have been published with reference to the contract conditions, there is a very interesting and full statement by Mr. A. Siemens on the subject, in which the financial aspects of the question are ably dealt with. It is somewhat difficult to see, however, upon what ground an earning basis of so much per mile of cable can be taken as of value in making an estimate; the revenue can in no way be directly dependent upon the distance two places are apart, as seems to be implied.

The Treatment of Persons Injured by Shocks.

THE suggestion made by Mr. Kolle in our correspondence columns for the systematic treatment of persons injured by electric shocks is a reasonable one. In spite of the most elaborate and farseeing precautions which have been adopted from time to time, fatal accidents have increased during the past few years; they are probably few when one considers the vast army employed on electrical work, still it is not altogether reassuring that there should be any increase in the number of lives brought prematurely to a close by accidental contact with live apparatus. It has been abundantly proved that the greatest safeguards which human skill and forethought can devise occasionally fail, with lamentable results. Prevention is always better than cure, but while accidents must be reckoned as part of our daily lot, there is every reason why Mr. Kolle's admirable suggestions should be carefully considered.

Electricity in Industrial Chemistry.

SOME of the papers read before the World's Congress of Chemists last year at Chicago are rather belated as regards their publication in full. Amongst these is one by J. W. Langley on the use of electrolysis in chemical processes, which is well worthy of being studied by all those who are endeavouring to apply electricity to the chemical industries. Whilst unwilling to go quite so far as the author, who sanguinely observes that this form of energy is destined to play a part throughout the wide field which stretches from metallurgy on the one hand to the production of delicate colours and perfumes on the other, we are at one with him in urging the electrical world to give chemical processes even more attention than they are now receiving. For, sordidly speaking, we believe there is "much in it." In Langley's paper the purification of copper, the refining of gold and silver, and the extraction of aluminium, are specially dealt with, since these are the directions, perhaps, in which the most success has been realised. More commercial success will probably be immediately realised, however, in some of the less ambitious applications of electricity to chemistry and metallurgy. Amongst the other industrial operations in which electricity has been tried and which are now on a fair way to commercial development are the bleaching of fabrics without chlorine, by means of electrolysed acidulated water; the treatment of sewage, and the tanning of hides. Seeing that in electrolysis we have a powerful analytic force at work, heaping up products of decomposition at each pole, it would be only natural to look for some means of utilising the oxidising and reducing actions of which the electrodes are the foci, and it is probable that this may be attained by turning to useful account the secondary reactions of the bath. A careful study of the conditions under which these secondary actions are a maximum and a minimum can scarcely fail to lead to many applications of the current in technical chemical work where electricity will be used primarily for bringing about oxidation and reduction, and only secondarily as an agent for electrolytic decomposition. There is, *inter alia*, one great desideratum, and that is a cheap insoluble anode. Platinum is prohibitory almost, on account of its great cost, and carbon will not long withstand oxidation. It is this lack which to-day, amongst other conditions, prevents electricity from being a serious rival to the ammonia process of making soda, to the Leblanc process for producing bleaching powder as a bye product, and to its utilisation as an oxidising agent. When the cheap insoluble anode is found it will open a wide door to the applications of electricity in the chemical arts.

Electrical Resonance and Electrical Interference.

THE solution of the differential equations which express the distribution of electricity on conductors of various forms and varying magnetic permeability is not always simple; and many assumptions have been made in regard to the constants which enter into these equations by Poincaré, Stefan, and other investigators. With the conviction that the experimental side of the subject should be more developed in order to decide, if possible, upon the truth of these assumptions, Prof. John Trowbridge has studied the oscillations of electricity with the aid of more powerful methods of dealing with periodic currents than have previously been used. In his experiments he made use of an alternating machine capable of giving a current of 120 volts, 15—25 ampères and suitable transformers, employing generally one primary or exciting circuit between two entirely separate and disconnected resonating secondary circuits. Photographs of the sparks produced were taken, which show distinctly the existence of electrical beats or interference between the independent circuits. In the photographs Prof. Trowbridge thinks there is evidence of what may be termed the electro-kinetic momentum of electricity. Something very like inertia is certainly shown by the gradual rise to a maximum, and the behaviour of secondary circuits to unidirectional impulses from a primary circuit. The formula $t = 2\pi\sqrt{L\,C}$ which Lord Kelvin supposed to apply only to a special case, does not apply at the instant of starting an oscillating current in a secondary conductor by means of a unidirectional flow in a primary circuit, and is true only after the full effect of the capacity of the oscillating circuit comes into play. The photographs show that at first neighbouring secondary circuits act like circuits without capacity, and the oscillations in such circuits rise to a maximum in intensity, and then fall after the rate is established. This is true also when air-condensers are employed. Evidence is also given that the oscillations in all the neighbouring circuits continue long after the unidirectional spark in the primary or exciting circuit has ceased, whether there is resonance or not, and is more marked where the circuits are not in tune, except so far as electrical beats tend to damp the oscillations of the secondary circuit. The paper from which this is condensed is to be found in the August issue of the *Philosophical Magazine*. It only outlines the method employed by Prof. Trowbridge, but this method seems to offer a very fruitful means of research.

DETERMINING THE POSITION OF A FAULT IN A SUBMARINE CABLE BETWEEN THE REPAIRING SHIP AND SHORE STATION, WHEN THE CONDUCTOR IS NOT BROKEN, BY THE "FALL OF POTENTIAL TEST."

By J. RYMER-JONES.

The value of Clark's fall of potential test, for localising a fault in a submarine cable, has long been appreciated, and should the fault in question have a high resistance, few tests, if any, afford more satisfactory results than does this one when carefully carried out.

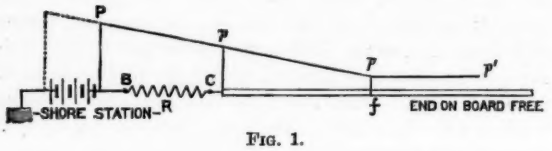


Fig. 1.

When both the testing stations are situated on shore, the potentials at the two ends of the resistance coils, R, and at the distant end of the cable, are readily determined by electrometer or by a condenser; but when a ship is engaged in cable repairs the same facilities are not offered for this test.

Owing to moisture in the air at sea and the ship's motion, an electrometer of sufficient sensibility is not a convenient instrument, and, in consequence of the rolling, the "throws" produced by the discharge from a condenser through a galvanometer are not comparable. Moreover, the fibre to which the magnet and mirror suspension of the marine galvanometer is attached, being fixed at both ends, makes discharge readings very abrupt, and, therefore, difficult to read. On this account a "Null" method only is suitable for capacity tests or measuring potentials by means of a condenser on board ship.

The writer is not aware of any method having been described in text books whereby this test may be conveniently carried out on board ship, so that the following, which has been employed with success, may be of service to others engaged in cable operations.

Shore Measurements.—These are made in the following manner: The clocks on the ship and on shore having been previously set to the same time, at some pre-arranged full minute the shore station applies the negative pole of a testing battery permanently to the cable through a resistance, R, roughly approximating the combined resistance of the conductor up to the fault, and of the fault itself, as obtained by a preliminary test, and charges a standard condenser alternately from the cable and battery end, C and B, respectively, of the resistance, R, the distant end of the cable being at the time insulated on board. A series of discharges from the condenser charged at each of these points is obtained during a given period (say 5 or 10 minutes); the number of readings desirable depending on their regularity, which, in the case of a high resistance fault, will probably vary considerably. As, however, the potential at B, will be very much less affected by a change in the resistance of the fault at *f*, than will be the potential at C, as large a number of readings as the time will admit of should be recorded from C, and only in the event of these varying very appreciably will it be necessary to do more than occasionally check the discharge obtained from B. Any irregular and widely varying readings, which are clearly indicative of great momentary changes having occurred at the fault, should be discarded. Indeed, in the case of a very difficult fault, the determination of its true position will very greatly depend on the individual judgment of the operator in selecting the most reliable readings.

Having secured a series of potential readings, P and *p* respectively, at the points, B and C, their mean values are taken as the true potentials at the two ends of the resistance, R.

The cable readings completed, the shore station next removes the testing battery from the cable, and connects it to a high resistance—Varley's slide resistance of 100,000 units if available—and charges the same standard condenser from some point of the resistance which will give a discharge equal to the "mean" reading previously obtained either from the cable or battery end of the resistance coils, R. It is only necessary to reproduce one of these, say *p*, as the ratio between *p* and P is already known, and the point of the slide resistance, which has a potential equal to P, can therefore be calculated. In fact it is not absolutely necessary to exactly reproduce even *p*, for since the battery potential falls regularly through the 100,000 units in proportion to the resistance, it is only requisite to note at what point of the resistance slides the condenser must be charged to give any reading approximately the value *p*, and the slide resistance and the discharge reading at this point together afford the requisite data to calculate the exact position on the slide, which would give the same potential as at *p*.

The potentials *p* and P are in this way obtained in terms of the slide resistance units. Supposing the mean potential reading *p* be reproduced when the condenser is charged at a point along the slide resistance, say, 25,000 units from the end connected to "earth"; and, moreover, suppose the ratio, *r*, between *p* and P to be as 1 to 2, then the condenser would have to be charged at a point 25,000 × *r*, or at 50,000 units from the zero end in order to give the mean discharge obtained at B.

That is to say, the potential at the

$$\text{Cable end of coils} = \frac{25{,}000}{100{,}000} \times \text{E.M.F. of battery used} = p \quad (2)$$

$$\text{Battery end of coils} = \frac{50{,}000}{100{,}000} \times \text{E.M.F. of battery used} = \text{P} \quad (1)$$

Note.—When using 100,000 units for the slide resistance the battery resistance is negligible.

In order to compare these potentials with that at the distant end of the cable, as measured on board, it is necesary to know the exact E.M.F. of the battery used on shore in connection with the slide resistance. This can be done by comparison with a standard battery cell similar to the one used on board for the same purpose, as will be explained later on.

Ship Measurements.—While the shore station is measuring the potentials, P and *p*, as already explained, the ship is engaged in ascertaining the potential, p^1, caused by the permanent negative current which the shore station has applied to the cable. The "Null" method employed for this is based on Sir William Thomson's capacity test, the only difference being that "potentials" instead of "capacities" are compared.

The connections for the tests are almost precisely the same (see fig. 2).

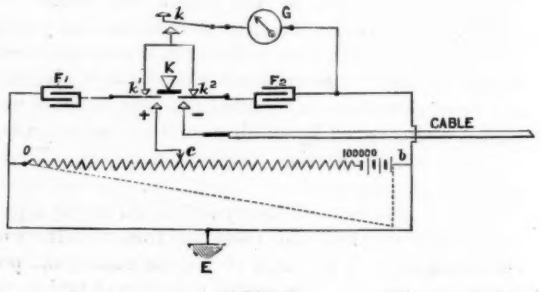


Fig. 2.

On board are two standard condensers, F_1 and F_2, say, of equal capacities. Should the fault at *f* have a high resistance, a capacity of one-third or one microfarad will be sufficient for each condenser, but if the fault resistance be not very great a larger capacity of about 5 or even 10 microfarads will be more suitable.

A battery, *b*, is joined up, as shown, to a high resistance—a slide resistance of 100,000 units, if available—and through this the potential regularly falls, as shown by the dotted line. The E.M.F. of the battery used need be of no particular value provided that at some point along the slide resistance a potential exists equal (but opposite in sign) to the potential, p^1, at the end of the cable. This will generally be much below the potential of the battery on shore, but let us

suppose that the ship uses about the same number of cells as the shore station, so as to allow a wide margin.

On depressing key, K, condenser, F_2, is charged *negatively* by the cable, and condenser, F_1, *positively* from some point of the slide resistance (to be found by repeated trials) which charges it to an equal and opposite potential to what the cable has charged condenser, F_2. Since these two condensers have an equal capacity and are oppositely charged, it follows that if, on allowing key, K, to rise and the keys, k^1 and k^2, to rise with it against their upper contacts, the two charges neutralise each other, the potential at the end of the cable will be equal to the potential at contact, c; or in other words, if, after allowing the charges to mix for say five seconds, as is usually done, no discharge passes through the galvanometer, G, when k is depressed, the potential of the slide contact, c, will then be equal (though opposite in polarity) to the potential at the end of the cable, and will be given by the slide index in terms of the total E.M.F. of the battery circulating through its coils. Thus, if a balance be produced when the slide contact is at 4,000 units from the end connected to "earth," the potential in volts at the end of the cable on board will be :—

$$\frac{4{,}000}{100{,}000} \times \text{E.M.F. of battery used} = p^1. \qquad (3)$$

Note.—The internal resistance of the battery being very small, compared with the 100,000 units in circuit, may be neglected.

If the batteries used on the ship and shore were of precisely the same E.M.F., the slide values given would represent the relative potentials at the points, B, C, and f, and would supply all the data required for Clark's fall of potential formula. Since, however, the batteries may differ greatly, it is necessary to know the exact E.M.F. of the battery used on the ship and on shore respectively, in connection with the slide resistances, in order to compare the slide resistance values obtained for the potentials, P and p, on shore with p^1 on board. This can be done by both the ship and shore stations comparing their batteries with similar standard cells whose E.M.F. is known in order to arrive at their true E.M.F. in volts; which latter, inserted in equations 1, 2, and 3 will make all of them comparable and applicable to Clark's fall of potential formula, viz. :—

$$\text{Distance of fault} = \text{B}\,\frac{p - p^1}{\text{P} - p} \text{ units from the shore station.}$$

On shore any of the known methods are available for comparing the E.M.F. of the standard cell, S, with the battery used with the slide resistance; but on board the more suitable way is a modification of Poggendorf's method —the slide resistance being used in the same way as Clark's potentiometer, see fig. 3.

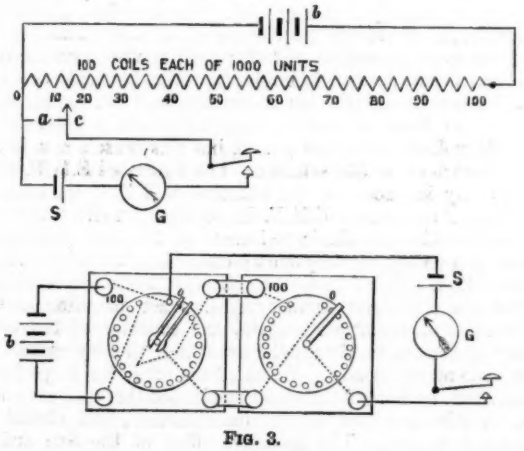


Fig. 3.

The slide contact, c, is moved up the scale until no current passes through the galvanometer, G; and when this is the case there is equilibrium between the potential of the standard cell, S, and the potential on the slide at this point of contact, c.

$$\text{E.M.F. of the battery} = \frac{100{,}000}{a} \text{ standard cells} \qquad (4)$$

which inserted in equation 3 gives

$$p^1 = \frac{4{,}000}{100{,}000} \times \frac{100{,}000}{a} \times \text{E.M.F. of standard cell used}$$

$$= \frac{4{,}000}{a} \text{ standard cells—where } a \text{ equals the resistance}$$

between the zero end of the coils and the point of contact, c.

If the standard cells on the ship and shore can be relied on as being exactly equal, it is unnecessary to know their E.M.F. in volts; but should the two differ, either their respective E.M.F. in volts must be known, or else the precise ratio which they bear to each other, in order to correct the ship's value, in equation 4, by this ratio, that the results may be comparable. Thus supposing it be known, from a recent comparison, that the standard cell used on shore has an E.M.F. 3 per cent. higher than the one on board, then a, in equation 4, becomes $a \times 1{\cdot}03$, and the E.M.F. on board

$$= \frac{100{,}000}{a \times 1{\cdot}03} \text{ standard cells (similar to the one used on shore).}$$

If, on the other hand, the standard cell used on shore has an E.M.F. 3 per cent. lower than the one used on board, then the E.M.F. of battery on board $= \frac{100{,}000}{a} \times 1{\cdot}03$ standard cells (similar to the one used on shore).

When making this test in order not to weaken the standard cell—on account of the larger battery working through it—the approximate position of the slide contact C, to produce equilibrium, should be previously calculated. A momentary light contact should then be made a little nearer to zero than the point calculated, so that the E.M.F. of the standard cell may predominate, and the contact can then be moved gradually up until equilibrium be arrived at.

On the other hand, it is important not to move contact C to a point nearer to the "zero" end of the scale than, say, 1,000 or 2,000 units at starting, so as not to reduce the E.M.F. of the standard cell.

It is not necessary that the two condensers on board be of the same capacity. Thus, supposing that the one charged from the slide resistance be one-fifth only of the capacity of that charged by the cable, a balance may be obtained, but in this case the former condenser must be charged by a potential five times as large as that at the cable end p^1; consequently, the slide contact would have to be at 20,000 units instead of at 4,000 units, as was the case when the condensers used were of equal capacity. In this case in order to arrive at potential p^1, it will be necessary to divide the resistance indicated by the slide contact C, by the known ratio between the capacities of the two condensers used, which, in the case supposed, would give $\frac{20{,}000}{5} = 4{,}000$ units.

STREET LIGHTING BY ALTERNATING ARC.*

By R. E. RICHARDSON and S. G. BUILER.

In the issue of the *Electrical Engineer* of July 4th, under the above heading, Mr. Armstrong, in the abstract of a paper read before the Chicago Electrical Association, makes many statements that tend strongly to mislead one, and the conclusions drawn and the suggestions put forth are of such a nature as to call forth the following, which puts series arc lighting and lighting by alternating arcs in their true relation to one another. As a basis, we will assume that the two systems are equally well constructed, and that the most modern apparatus is used in both cases; in fact, each plant constructed according to modern ideas. Mr. Armstrong has evidently not considered the two systems as being equally well constructed, or has lost sight of this important item in his paper. To avoid argument, we will agree that, under certain conditions, there might be a saving in cost of conductors in favour of the alternating system, but such conditions would

* New York *Electrical Engineer*.

naturally be special cases, and it is not *special* but *practical* systems of distribution which should be considered. Cases can be readily cited where the cost of alternating systems of distribution will be at least 10 per cent. greater than that of the series; in fact, in ordinary cases it would exceed the latter.

The writer of the article is evidently in error as to the statement that the cost of an alternating lamp with transformer does not exceed the cost of a first-class series lamp. The highest grade series lamps can be bought for from $20 to $25 apiece. The same can be said of alternating lamps. The lamp which would meet the conditions as specified in the article, namely, that of a focussing lamp with reflector over it, is the highest priced alternating lamp on the market, and the company manufacturing this lamp owns a broad patent covering the use of this reflector, absolutely barring out other companies from using it. The net price of a high grade transformer, having an output sufficient for one lamp at 30 volts, is about $20, which would make the cost of an alternating lamp with transformer from $40 to $45 per lamp, against from $20 to $25 for a series lamp. The cost per lamp of dynamo capacity is, however, in favour of the alternating, the series costing about $5.00 per lamp more. Another point which Mr. Armstrong has overlooked, is that there is no double carbon all-night alternating arc lamp upon the market. This would necessitate the re-trimming of lamps for an all-night run, which is a very important item in central station operation. We do not think Mr. Armstrong will find that the enclosed globe he speaks of is a decided success or can be applied to all lamps.

In the next article, Mr. Armstrong speaks of the advantages gained by running arc lamps in multiple, in that every lamp is independent of the rest. With a modern high grade series lamp the same can be said, as all lamps are equipped with an automatic cut-out, so that in case the lamp fails to feed properly it automatically cuts itself out, without interfering with the other lamps on the circuit. It can be readily seen that the alternating arc possesses no advantage over the series arc lamp in the above respect. Further attention is called to the fact that the most an alternating lamp could do would be to blow the fuse. In case of the series lamp there is no necessity for providing such a device, thereby doing away with the extra labour necessary to replace the fuses. Mr. Armstrong also neglects the fact that fuses do not always perform the service for which they were intended, and furthermore, that careless linemen will oftentimes replace the fuse by a piece of copper wire. This is known to have been done in many cases. Where such a thing does occur, it virtually means the destruction of the lamp and transformer.

Referring to the further advantage claimed in favour of the alternating lamp, from the fact that a break in the line will not affect the entire system, we would ask what result would follow from the breaking of the primary line, but we hardly expect in a line that is properly constructed for either system of lighting, that the question of breakage should be considered at all. In reference to the joints interposing any resistance in the whole system, it is thought (as we are considering a well-constructed plant), that an item of this nature is not deserving of any attention whatever. It is stated that the voltage used in connection with the alternating arc lamp is harmless, and that they can be trimmed with safety at any time. Mr. Armstrong has evidently lost sight of the fact that there are perfectly successful automatic cut-outs, or what are known as "separable hangers" used in connection with the series arc work, where the lamp can be entirely disconnected from the line and still maintain the continuity of the circuit. By the use of the above device, series lamps can be trimmed with absolutely no danger. Referring to the next paragraph which deals with the illuminating power of a lamp, a suggestion is made as to the use of a reflector with the alternating lamp. As stated before, this reflector can only be used successfully with a focussing lamp, and one company owns and controls exclusively a patent covering the use of the reflector in this way. As to the case of street lighting, where it is stated that a portion of the rays will be reflected from the under-surface of the foliage, we would hardly expect to find in all cases, trees growing conveniently near the lamp, especially in large cities, or the trees covered with foliage during the winter, when light is needed the most. It might be well to state in reference to tower lighting by direct-current arc, that this method of lighting was one of the very first adopted upon the introduction of series arc lighting, and has been practically abandoned.

In comparing the energy of the two systems, it is stated that the efficiency of good series generators is from 80 to 85 per cent., but after a few years, it falls to 70 per cent. and even as low as 50 per cent. We are not aware of the type of machine that this refers to, but would state that modern series arc machines are sold under a guarantee of 90 per cent. efficiency, and as to deterioration, if the station be properly handled, we do not see any reason for a lowering of the efficiency. In regard to the statement that reports from 300 arc light stations show that the armature repairs alone, averaged $3.00 per year per lamp, we can only say that we feel sorry for the persons holding stock in such poorly equipped and operated stations. We have on record a case where 25,500,000 lamp hours were run without losing an armature, 20 machines being used for this service. Our experience has not led us to believe that it is a commonly known fact that arc armatures are more likely to be damaged than alternating armatures, and we cannot agree with the writer in his belief. In the matter of carbons, it is a most important item to procure cored carbons suitable to be operated with a low voltage alternating current, without having to pay from two to four times what perfectly satisfactory series lamp carbons can be bought for; and while the manufacturers are certainly considering the matter, there is not a carbon manufactured in this country which will give the best results, or results equal to those obtained from using imported carbons. As to the large type of generators, we would further call attention to the fact that to-day generators for series arc lamps of 200 light capacity are on the market, and further, that arc machines are being built to-day for direct connection, their efficiency being very high.

We think that if Mr. Armstrong will look into the cost of step-down transformers of sufficient capacity to operate his ideal station, he will find that the cost of wire is a very small item compared with the cost of his system of distribution; and the cost of running his feeders from his station some three or four miles out in the country will also be quite an item, so that by the time he has this station built, he will find that it will net about three times that of an equally good station located at some more central point. The cost of conduits is an item of no small moment, and this, together with the expense incident to laying them, besides having to provide lead-covered conductors for such an installation, would practically prohibit the "ideal" plant when cheaper and better service can be had from one more conveniently located nearer to the city.

In connection with the transmission of a large current at a potential of 4,000 volts alternating, in the article under discussion, the fact of self-induction and capacity of the line has been entirely lost sight of. In the first place, Mr. Armstrong would be unable to find any manufacturer willing to guarantee his cable for such service with the conditions as laid down. It might, however, be mentioned that high potential distribution is practicable, such, for instance, as at the Deptford station, London, where a potential of 10,000 volts is successfully used, but this system cost in the neighbourhood of $30,000,000. The impressed E.M.F. must be greatly in excess of the effective E.M.F. at the load, on account of the counter E.M.F. due to inductive effect, to which must be added the ohmic resistance of the line (this latter item is probably the only one which has been considered in the calculations referred to in the article). These are considerations which engineers cannot neglect when planning such a system of distribution. Again, the capacity of the cable may be such as to disrupt the sheathing, thereby grounding one side of the system. Provided the other leg is perfectly insulated, no bad effects would result, but the danger would be greatly increased in the manipulation, and should be guarded against. The inductive effect of the line and of each and every converter as well as that of the lamp itself, will make it necessary to increase the capacity of the generating plant to an extent that would exceed the cost of the series arc plant of equal capacity as regards the number of lamps.

We do not intend that this shall be a negative article, or one which shall be construed as against the use of alternating systems for arc lighting, as we are perfectly well aware

that in many cases, the advantages are largely on the side of the alternating system, but the chief advantage, which is not dwelt upon at all, and one which will show itself most prominently, and be appreciated by the stockholders, (especially in small towns or cities), is due to the fact that wherever the alternating line goes, we have a system that is more or less flexible, inasmuch as it is possible to supply either incandescent or arc lamps, or both. It is quite common to find in a moderate sized town, a plant with both arc and incandescent machines, the arc lines being generously run not only to the centre of the town, but to the outskirts, the incandescent lines being run over to the business centre or where a large supply of lights is needed. A person on the outskirts is thus unable to get incandescent light, although the arc line may run in front of his house, and it will not pay the station to run the necessary wires to supply him with a few lights; whereas, if they had originally placed an alternating system instead of series arc machines, as above shown, the entire town would be wired for either arc or incandescent, as the requirements demanded. It is a well-known fact that after a station's receipts equal its expenditures, the addition of light up to the capacity of the machine, especially in the case of incandescent, does not materially increase the cost of operation, and that the revenue obtained from these extra lights can be considered almost entirely profit. In the case of an alternating system, where the arc lamps for street purposes are used, the picking up of 200 incandescent lights on the outskirts would increase the profits probably $150 per month, and, as this would be equivalent to 10 per cent. on an $18,000 investment (but in the case cited practically no investment being required), a practical station man and the stockholders would thoroughly appreciate it. If the points brought out by Mr. Armstrong are those which deserve more attention than others, we think his article would tend to prove that alternating apparatus for arc light is a failure compared with the series lighting.

We will further call to mind the fact that, with the system proposed, a transformer would necessarily be required for each arc lamp. Now, after planning such a system, the amount of wire necessary for an additional lamp would incur the running of wires of great circular-millage and the installing of a transformer of larger capacity. The inflexibility of purely arc lighting by alternating current is, therefore, obvious, and the "ideal" plant of Mr. Armstrong is absolutely impracticable.

A correspondent, signing "Buffalo Bill," has since written to the New York *Electrical Engineer* as follows:—"In the issue of the *Electrical Engineer* of July 4th, in a paper read by Mr. Armstrong before the Chicago Electrical Association, he calls attention to several good points in favour of alternating arcs for street lighting. As usual, some one jumps all over Mr. Armstrong a few days later and tells us all about it. But in this case there were two, Mr. R. E. Richardson and Mr. S. G. Neiler, in the issue of the *Electrical Engineer* of July 25th, 1894. But in their article they make several very misleading statements, a great many more than Mr. Armstrong, and, what makes matters worse and seem queerer, is, that it should take two full grown men to do so little. Messrs. Richardson and Neiler say: 'To avoid argument (this is very kind of them) we will agree that, under certain conditions, there might be a saving in cost of conductors in favour of the alternating system, but such conditions would naturally be special cases.' Here Messrs. Richardson and Neiler must agree that there are a great many special cases to be looked after and taken care of. They next state that because of an arc lamp being constructed under broad patents it would not be admissible; and, farther on, they say that Mr. Armstrong has overlooked the fact that there is no double carbon all night alternating arc lamp upon the market. Here I wish to state that Messrs. Richardson and Neiler have made a great error, a mis-statement in the extreme, because there are alternating arc lamps upon the market that are guaranteed to burn 24 hours, and at 450 watts, and to give 2,000 C.P., and, still more, they are of the highest standard and burn equally well on either high or low frequency and burn practically noiselessly. Farther on Messrs. Richardson and Neiler state that in case anything goes wrong with series or high-tension arc lamps, they are provided with automatic cut-outs. This is all true, but they do not state what they cut in when they cut out; and, where an objection arises to putting in a new fuse in cases where alternating arcs are run in multiple, one should not lose sight of the fact that automatic cut-outs are a great deal more liable to blow out than fuses, besides being a hundred times more expensive to replace. Next they say that Mr. Armstrong also neglects the fact that fuses do not always perform the service for which they were intended. This verse is remarkable, simply astonishing. Wonder how about automatic cut-outs. In another passage they say it has been known that careless linemen have often put in copper wire for fuses, and they go on to state that where such things do occur it virtually means the destruction of both arc lamp and transformer. The above is another very misleading and untrue statement. I will also add here that if copper wire fuses were used more universally there would be a great deal less trouble all round."

SELF-MOTIVE CARRIAGES.

(The Prize Winners of the "Petit Journal" Competition.)

The following brief description of the carriages that gained first prizes is taken from *La Nature*.

Messrs. Panhard & Levassor's petroleum carriages, with two seats and four seats (1st prize, divided with the sons of Messrs. Peugeot; 2,500 francs). Four of these carriages were entered for the competition, and all arrived at Rouen in less than 11 hours. They were all propelled by the gasoline motor of the Daimler type, with two cylinders, which were placed in the fore part of the vehicle, and thus rendered easily accessible. This motor, the axle of which is parallel to that of the carriage, turns at a constant angular speed of 700 revolutions per minute, and works the hind wheels by a friction pulley, and a system of gearing which can be readily manipulated by the driver by means of a pedal, that allows of three different normal speeds of about 6, 12, and 18 kilometres per hour. The powerful brake, of the Lemoine type, is worked by a pedal. This brake acts on the intermediate axle, thus avoiding the wear and the slipping of the India-rubber tyres with which the wheels of the carriage are often furnished. In case of emergency, or for steep inclines, the wheels are acted upon directly by a brake worked by a lever placed at the right of the carriage, within reach of the driver's hand. The manipulation of the brakes automatically disengages the motor, which continues to turn notwithstanding the stopping of the carriage. We might mention many other ingenious arrangements with regard to the directing of the vehicle, the starting of the gasoline motor, the carburetting apparatus, the mode of preventing the noise caused by the action of the motor, but we have not space for all these details, and can only say a few words as to the general character of the vehicle. The weight of a carriage with two seats, when ready to start, is about 700 kilogrammes; in the carriages with four seats it amounts to 800. The power of the motor in the first is 240 kilogrammes per second, in the second from 280 to 300.

The cooling of the cylinders of the motor is effected by a circulation of water contained in a reservoir holding 40 litres. This water becomes heated and evaporates, especially in summer, and must therefore be replaced at the rate of 7 to 10 litres per hour. The *gasoline* used in the Daimler motor has a density of ·7 to ·705; the reservoir which contains it and which is placed in the fore part of the carriage, is sufficient for a journey of 80 kilometres, but by using an additional reservoir behind, a journey of more than 300 kilometres might be made. The mean consumption is about 1 litre for 10 kilometres.

It is not within our province to speak here in praise of Messrs. Panhard & Levassor's carriages, or to dwell upon their advantages: roominess, speed, endurance, comfort, &c. The result of the competition speaks for itself.

Gasoline carriages, entered by the Sons of Messrs. Peugeot Bros.—Cab with three seats, and phæton with four seats (1st prize, shared with Messrs. Panhard & Lavassor, 2,500 fr.). The principal difference between Messrs. Panhard & Lavassor's carriages, and those of Messrs. Peugeot lies in the place assigned to the motor, which in this case is in the hind part

of the vehicle. Their advantages are equal to those of the carriages with which the 1st prize has been shared.

From this brief description, and judging by the carriages that obtained prizes or that fulfilled more or less satisfactorily the conditions of the competition, we are led to the conclusion that the steam motor is far inferior to the gasoline motor as a means of propulsion without danger, suited to the convenience of travellers, and not too expensive. Without having yet come altogether within the reach of the tourist and the trader, the gasoline carriage has certainly entered the domain of practical application; the apparatus used are being improved every day thanks to the teachings of experience, small defects disappear, the mechanism is simplified, and the petroleum carriage will soon have attained the highest degree of perfection of which it is capable. It would be rash, writes M. Hospitalier, to say or even to hope that it will prove to be the self-motive carriage of the future, but it has before it a vast field of application of which the *Petit Journal* competition has clearly shown the value.

COAST COMMUNICATION.

The *Standard* of the 28th ult. gives an interesting sketch of the history of lightships and light service. With the writer of the article human sympathy is evidently uppermost. He says: "Science, too, has done much to destroy the feeling of perfect isolation. In the not too remote future every lightship will be connected by telegraph with the shore." Exactly; we hope so, but we thought a certain number were already, and we were certainly under the impression that the object of the Government in spending money on telegraphic communication was not so much to ensure the inhabitant or inhabitants of the lightship being well posted up in race-course winners and verbatim reports of the House of Commons speeches, as to provide a ready means of communication between any passing ship (or any ship anchored owing to weather) and her owners, or her passengers' belongings.

Secondly, and more especially, the object of the Government was, presumably, to meet the contingency of a wreck so that help might be signalled for and obtained from the mainland before it is too late, or whilst the tide permits of the ship being hauled away. Without electrical communication in "thick" weather ships are always liable to get dangerously close to the mainland in order to effect their signals.

If any one wishes to obtain a good general idea of lighthouse and lightship communication, and the different schemes by which it has been, and is, secured, he could not do better than read an interesting paper on this subject to the Balloon Society by Mr. Henry Benest, Assoc.M.Inst.C.E., of two or three years ago, and we would recommend this to the *Standard* correspondent. In this will be found various methods to ensure the protection of the telegraph cable from abrasion with the lightship moorings, including an ingenious device due to Mr. M. H. Gray, F.G.S., engineer-in-chief to the Submarine Telegraph Engineering Department of the Silvertown Company.

One of the principal points to be aimed at, is that of keeping the cable permanently at the bottom and thus avoiding chafing. Mr. Gray's device to effect this object (to quote Mr. Benest's paper) consists of "flexible piping formed of a series of alternate wrought-iron links and short cast-iron pipes," through which arrangement the cable would be threaded. Mr. Benest mentions Portland cement as a means of absolutely burying the cable in the form of an immovable crust. Mr. M. H. Gray appears also to have a plan of connecting up the distant lighthouse or lightship telegraphically by two or more branch cables approaching in different directions, thus minimising the risk of telegraphic communication being at any time entirely broken off. We believe that Mr. Edward Stallibrass, Assoc.M.Inst.C.E., has also a plan for arriving at a similar result.

The first permanently successful case of telegraphic communication being effected with a lightship or lighthouse seems to be that carried out for Lloyds by the Silvertown Company, connecting Ireland with Tory Island and its lighthouse, in 1890, which has not, we believe, given any sort of trouble since. Mr. H. Benest dwells on the importance of all the telegraph lines along our coast being underground cables rather than overhead wires, in view of a possible war when overhead lines could be made short work of by the enemy. He also throws out the timely suggestion of something being really done in the matter by the Government, and points out that the maintenance might well be undertaken by the Post Office, or, failing them, by the Trinity House.

This was in 1892, and since then a Royal Commission has been appointed, which has been sitting at disjointed intervals to collect and sift evidence and afterwards report thereon.

Of late, inductive telegraphy has also been turned to some practical account in this direction, as mentioned in our issue of the week before last.

THE LOAD LINE IN TELEPHONE EXCHANGES.*

By A. V. ABBOTT, Jun., Am.Soc.C.E.

A study of the variations in loading to which dynamic plants are subjected forms one of the most interesting of engineering investigations. The station loads carried by electric and cable railway plants have, during the past few years, formed a prolific topic of scientific discussion, and the results have revolutionised certain departments in steam engineering. Similarly, the managers of electric light plants are perpetually seeking to realise a maximum output with a minimum of invested capital and operating expense.

Among interesting load lines, those presented by the daily burden on telephone exchanges exhibit some features of peculiar interest, well worthy of professional consideration. The telephone exchange is merely the mechanism whereby different parties may be rapidly and reliably placed in talking relations with each other, and the exchange only fulfils its office in proportion to the efficiency with which this end is accomplished. Considering that some of the larger exchanges in this country are handling messages at the rate of 100,000,000 a year, the importance of a consideration of the exchange load line becomes apparent.

The shape of the load line in any exchange is evidently governed partly by the speed and facility with which the operators are enabled to perform the various evolutions described as necessary to make connections between the subscribers, and partly by the nature of the business done by the exchange. The work done by the operator thus becomes an important governing factor in the load line.

About 97 seconds seems to be the average of most conversations, and about 10 seconds more suffice to receive the clearing-out signal and disconnect the parties, leaving the lines ready for another call. Such is, diagrammatically, the history of the operations and time expended in completing the average local conversation between two subscribers extending into a single office.

When a message proceeds through two offices, it must of necessity pass through the hands of two operators through two switchboards.

In the local connection, the party called for answers in about 33 seconds, while in the trunk connection some 85 seconds are consumed in passing through the second office and in obtaining an answer from the party called for. For this curve, also, it would appear that trunk conversations last a little longer than ordinary local calls. The operation of disconnecting, however, seems to be performed with equal rapidity.

To determine the load line, it is now customary in nearly all the larger American exchanges to make frequent tests of the amount of business. To this end, recourse is had to what is termed "operator's peg count." In front of each operator is placed a panel containing the subscribers' spring jacks, each one bearing an appropriate number. The operator is supplied with a wooden peg, which at the commencement of the count she inserts in jack, 0. As fast as calls are received she moves the wooden peg from hole to hole, counting calls something after the fashion of a cribbage

* Extracts from a paper read at the Annual Convention of the American Society of Civil Engineers, Niagara Falls, June, 1894, and appearing in full in the N.Y. *Electricity*, July 4th, 1894.

board. At the end of each hour, the superintendents in the operating room note the position of the peg, thus determining the number of calls which have been received by the individual operators. At the end of the day, the sheets bearing the facts thus obtained are tabulated, and the results plotted in a convenient form for inspection.

Plate I. is a chart of the business transacted in a week by the main office of the Chicago Telephone Company. At the time this count was made this office embraced about 5,000 subscribers, while the entire exchange numbered some ten offices, including about 10,000 subscribers.

In the diagram, the vertical axis indicates the number of calls made, while the horizontal axis is divided into hours throughout the whole week. The diagram commences at midnight on Sunday and extends to midnight on the succeeding Saturday. The full lines in the diagram indicate the subscribers' calls which are made and completed in the office under consideration. The fine dotted line indicates the in-coming trunk line calls, namely, those calls which originate in subscribers located in external offices, and which are trunked into the main office, while the broken dotted line indicates the out-going trunk calls; that is to say, those calls which are received by subscribers in the main office, and which are not completed there, but are trunked to subscribers located in some of the outlying offices. From midnight to 7 o'clock on Sunday morning little business was done by the exchange, the number of calls in any one hour barely reaching 100. From 7 to 10, the business steadily increased, reaching at 10 o'clock a maximum of about 350 calls per hour. Another maximum occurs between 12 and 1, reaching about 375 calls. From this point the business steadily decreases, reaching a minimum between 2 and 3 on Monday morning. From 3 o'clock to about 7 there is a slight increase. At 7 o'clock the business of the day begins, the number of calls rising rapidly from 200 per hour at 7 o'clock to a maximum of 6,920 calls an hour at about 10.15. From 10.15 to 12.30 the business decreases, being reduced to 4,150 calls per hour during lunch time. From 12.30 to 2.15 the business again increases, reaching a second maximum of 5,950 calls. From this point a rapid decrease is observed, to the rate of about 500 calls an hour between 7 and 8 o'clock in the evening. The curve at this point turns, and slowly decreases again until about midnight.

Between 2 and 3 o'clock a slight increase is observed, due to newspaper business, while the minimum of the entire 24 hours is reached at 4 a.m., at a rate of about 50 calls an hour. Comparing the business of the successive days in the week, it will be observed that rather more business is done on Monday than any of the succeeding days, with the exception of Saturday. During Tuesday, Wednesday and Thursday the business decreases, reaching a minimum on Thursday. On Friday a slight increase is observed, while on Saturday the effect of the summer half holiday is plainly marked. Here it is evident that an effort has been made to transact the entire business of the day in the forenoon, the maximum being reached at 11 a.m., with a rate of about 7,600 calls an hour. From 11 a.m. the business drops sharply, there being no indication of any noon hour, but the holiday effect is also noticeable in the increased number of calls which are made during the evening hours, from 6 to 9 o'clock. While the chart thus given may be considered a typical representation of a week's business, it is necessary to take carefully into account the modifying effects of the general state of business in the city, the effect of any unusual occurrence, such as holidays, large fires, railway accidents, or other contingencies, and particularly the state of the weather. Thus, during the summer time, especially in the midsummer months, the business of the exchange is liable to fall off, owing to general slackness from vacation time, and also due to fine weather making pedestrianism attractive. Conversely, in the winter time, when business is more brisk, or when stormy weather is conducive to office confinement, the business of the exchange may rise enormously.

A study of the load-line, however, is more particularly advantageous in adjusting the operating force to the business of the exchange in a way to make the quantity and quality of the service a maximum with a minimum of operating expense.

In adjusting the number of operators to the business transacted, it must be recollected that it is impossible to decrease the operating force precisely in accordance with the service demands. The operator is necessarily a unit, and one of considerable magnitude, particularly when considered in proportion to a single call. Thus, to serve half a dozen subscribers will require one operator, while 100 could be served with equal facility. As it is impossible to subdivide the individual operator in proportion to the business to be transacted, there occurs a great discrepancy between the force line and the load line in certain parts of the diagram.

At night time, for example, the number of operators rises far above the actual force which could transact the business. It is essential to watch the entire switchboard, as an occasional call may come in upon any section, and as the switchboard in the office under consideration is nearly 200 feet in length, quite a large operating force is required simply for supervision, irrespective of the number of calls to be answered. It is also impracticable to change the working hours of the force in a manner to coincide exactly with the variations in the business. While this can be done to some extent, it will cause only a partial agreement between the force line and load line. As an example, however, of what has been done in this direction, as developed by a study of exchange load lines, reference is made to one of the diagrams, showing that 6,900 calls were handled with 82 operators, and 8,450 calls were handled with a maximum force at any time of 72 operators, while the whole force line indicates a number in closer agreement with the load line.

Taking the whole exchange in the time intervening between the two peg counts, which are charted, the business increased about 8 per cent., upwards of 1,000,000 additional messages a month, while the operating force was decreased

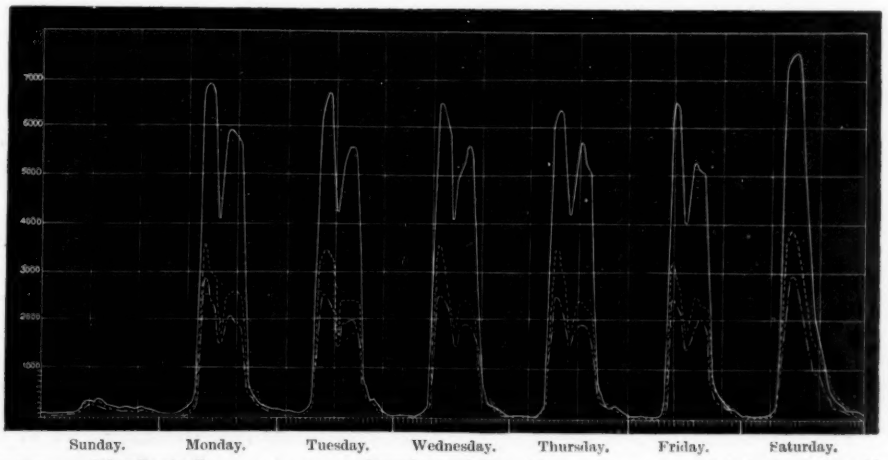


PLATE I.

some 18 per cent. with marked improvement in the quality of the service attained.

It is also curious to note the effect on the load line of the kind of district in which the exchange is located. Thus, in one office it will be noticed that almost no business is done after 8 o'clock p.m., while in another, between 7 and 8 p.m., a maximum occurs of nearly 600 calls an hour. This is explainable when it is considered that the first office is located in a district which is exclusively a large business district, the offices of which uniformly close between 5 and 6 p.m., while in the case of the other office, the district is to a great extent a residence one, and the maximum indicated between 7 and 8 o'clock is caused by the formation of evening appointments.

In a like manner the study of such load lines forms an exceedingly valuable source of information in the location of branch exchanges and the distribution of subscribers' lines. It is quite evident that the establishment of branch exchanges increases the cost of operating, as it requires the expense of additional buildings, additional supervision, and a general increase in the non-productive portion of operating expenses. Where, by means of a branch exchange the capital invested in the subscribers' lines may be decreased by shortening those lines, resulting in such a saving as to warrant the increase in operating expenses, a branch exchange becomes profitable. On the contrary, if the business in the district covered by the branch exchange is of such a nature as must necessarily come to the main office, the establishment of a branch exchange must be supplemented by such a large number of trunk lines, as practically to extend the line of each subscriber into the main office. Thus, under such circumstances, the establishment of a branch exchange becomes an impediment rather than an assistance, as the speed of the service is reduced, greater expense is incurred, and no particular saving can be made in the capital expended.

Such are some of the more salient deductions to be drawn from a study of telephonic load lines.

THE PACIFIC CABLE.

The resolutions passed by the Colonial Conference, held in Ottawa between June 28th and July 8th, have resulted in immediate steps being taken for the establishment of direct telegraphic communication between the dominion of Canada and the Australasian colonies. Tenders have been invited for the manufacture, laying, &c., of the cable under three different forms, viz. :—

Form A.—*The cable to be owned and controlled by Government; to be worked under Government authority, and to be kept in repair by the contractor for three years.*

Form B.—*The cable to be owned, maintained, and worked by a subsidised company.*

Form C.—*The cable to be owned, maintained, and worked by a company under a Government guarantee.*

Form A requires contractors to state the lowest cash price for which they will be prepared to supply and lay the cable, and the annual payment for which they will maintain it in efficient condition for three years after the whole line shall have been completed and put in operation. Form B requires the contractors to find the capital for, establishing, working, and maintaining the cable in efficient condition, for a subsidy to be paid to them annually for a term of years by the contributing Governments. The offers are to state the amount of subsidy to be paid and the number of years for which it will be needed. The *maximum* rates to be charged on messages between Great Britain and the Australasian colonies under this arrangement are to be three shillings a word for ordinary telegrams, two shillings a word for Government telegrams, and one shilling and sixpence for Press telegrams. The charges on messages between Canada and the colonies to be proportionate. Form C requires the same conditions as Form B on the part of the contractor, and the offers are to state what guarantee of gross revenue will be required, the difference between gross earnings and the amount guaranteed to be made good each year to the company by the contributing Governments; the tariff of charges to be subject to official sanction. Eight routes are given, over which the cable may be carried, of the respective lengths 7,145, 7,175, 8,265, 6,246, 6,127, 7,078, 6,293, and 6,030 knots. Of these, three have a double terminus at the southern end, one branch going to New Zealand and another to Tweedmouth near the boundary of New South Wales and Queensland; three go direct to Queensland and two to New Zealand only. The first route contains the longest main section, viz., from Vancouver Island to Fanning Island, a distance of 3,232 knots; and the seventh route, the shortest main section, viz., from Vancouver Island to Honolulu, a distance of 2,280 knots. The limit of time for the completion of the cable is three years from the date of the contract, but it is proposed that offers may be made on the basis of the shortest period within which the undertaking can be accomplished.

The speed of working of any section must not be less than 12 words per minute.

In a letter from Mr. Sandford Fleming to the Minister of Trade and Commerce, Ex-president of the Colonial Conference, he estimates that on the completion of the cable in 1898, the business for that year may be set down at 1,105,000 words, which, reckoned at 2s. per word, would yield a gross revenue of £110,000, this estimate being for European work only. Assuming the cost of the cable and its maintenance for three years to be £2,000,000, the revenue account for 1898 would stand as follows :—

Estimated earnings		£110,000
Interest on £2,000,000 at 3 per cent.	£60,000	
Staff and management...	30,000	
		90,000
Surplus revenue		£20,000

Mr. Fleming estimates the annual increase of business at 18 to 20 per cent.; but taking it at 15 per cent., the business for 10 years after completion will be as follows :—

	Gross earnings.	Interest and working expenses.	Surplus.
1898	£110,000	£90,000	£20,000
1899	126,500	90,000	36,500
1900	143,000	90,000	53,000
1901	159,500	90,000	69,500
1902	176,000	90,000	86,000
1903	192,500	90,000	102,500
1904	209,000	90,000	119,000
1905	225,000	90,000	135,500
1906	242,000	90,000	152,000
1907	258,500	90,000	168,500

As there have been eliminated all but the fixed charges on revenue for the first three years, an examination of the above table will show that the surplus up to the fourth year accumulates to £109,500, which sum, together with the annually increasing surplus thereafter accruing, would be sufficient to meet all charges for repairs and maintenance, and leave a balance to be carried to a cumulative reserve, for renewals.

Appended to Mr. Fleming's communication is a statement of Mr. Alexander Siemens, with reference to the general questions of the cost, laying, route, and revenue of the cable. This statement is chiefly of interest to the general public, whose acquaintance with such matters is small.

THE CAPACITY AND CONSTITUTION OF DIELECTRICS.

By ROLLO APPLEYARD.

Mr. Charles B. Thwing describes in the present number of the *Physical Review* an extensive series of experiments which he has lately carried out upon the specific inductive capacities of a large number of dielectrics; his object being to find, if possible, the law connecting the capacity with the chemical constitution of bodies. The method adopted in these determinations was suggested to him originally by Prof. Hertz, and depends upon the principle of resonance. Since the period of the electrical oscillations which occur at the discharge of an electrical system depends only upon the capacity and self-induction of the system, it follows that if two systems, A_1, A_2, have the same self-induction, their

capacities, C_1, C_2, will be equal when both systems are in resonance with a third system, A_3, whatever the self-induction and capacity of the latter may be. A convenient method of employing this principle for the measurement of capacities requires (1) a primary circuit with variable air-condenser and an induction coil of moderate dimensions; (2) a secondary circuit with variable air-condenser which may be replaced by the condenser whose capacity is to be measured; (3) a convenient means for measuring the amount of current developed in the secondary circuit as the the relative capacities of the two circuits is varied. For the latter purpose a dynamometer, invented by Prof. Hertz and described in the *Zeitschrift für Instrumentenkunde*, III., p. 17, 1883. was used, with some modifications, by the author. The primary circuit consisted of a quadrangle of copper wire 60 cm. square, the wire being 1 mm. in diameter. The secondary circuit was of the same dimensions, and was distant 15 cms. from the primary, with its sides parallel to it; the electrometer was included in the side of the secondary which was opposite to the spark-gap side of the primary. The primary condenser was formed of two circular zinc plates, each 40 cm. in diameter, one of which is attached to a fixed support, the other to a support which moves upon two stout glass tubes, and is provided with a pointer and millimetre scale. The secondary circuit contained a Kohlrausch condenser, with plates of 15 cm. diameter, and was fitted with adjusting screws and a scale and vernier reading to tenths of a millimetre. A table was calculated for this condenser for all values of a from 0·1 mm. to 30 mm., by Kirchhoff's formula:

$$C = \frac{R^2}{4a} + \frac{R}{2\pi}\left(\log \frac{8\pi R}{a} - 1\right)$$

where R is the radius, and a the distance apart, of the plates. The tests were made on the assumption that the apparent capacity of a dielectric is independent of its conductivity. In the case of substances with a perceptible conductivity, the determinations were of less exactness owing to the consequent smaller dynamometer deflections to be observed.

The solids which were to be examined for S.I.C. were formed into circular plates, and clamped between metal discs, varying in diameter from 3 to 12 cms., the capacities being computed by Kirchhoff's formula given above. The first tests upon liquids were made with a condenser consisting of two small spheres supported at the middle of a glass cylinder upon wires admitted through the walls of the cylinder. Finally, however, this system was replaced for an arrangement of concentric cylinders having the liquid in the interspace. Owing to the difficulty of obtaining many solid substances in the form of plates, the author was led to use the cylindrical condensers for the measurement of solids as well as liquids. The condenser was first weighed, then filled with the solid substance in the form of powder, and again weighed. The space between the solid particles was then filled with a liquid in which the given solid was insoluble—usually alcohol or ether. The volume of the substance is computed from its known density, and this volume subtracted from the volume of the condenser gives the volume of the liquid. The specific capacity of the mixture is equal to the volume of the liquid times its capacity plus the volume of the solid times its capacity, divided by the total volume of the mixture, and from this relation the S.I.C. of the solid is at once found.

The results have reference to a great many vexed questions relating to dielectrics; they include tests upon ice and water and upon various aqueous mixtures with acids and alcohols, as well as numerous tests upon salts and hydro-carbons. There is shown to be a connection between the dielectric constants of the alcohol series; and an attempt is made to express it as a function of the chemical constitution of the dielectric. The variations produced by temperature, and the high value found for sugar and glycerine, as well as the difference between the two propylalcohols, made it probable that the specific capacity varies with the density. It was further clearly noticeable that the members of the series containing a large proportion of the atom group "hydroxyl" had relatively large values. The assumption was then made that

$$K = \frac{D}{M}(a_1 K_1 + a_2 K_2 + \ldots),$$

where D is the density, and M the molecular weight of the substance; K_1, K_2, &c., constants for each element or atom group, and a_1, a_2, &c., the number of atoms of the element in the molecule. The values for hydrogen, K_h, and for carbon, K_c, were determined from such substances as contained only those elements. The values were so nearly in the ratio of the atomic weights of the substances that that ratio was adopted. Calling then, $K_h = 2{\cdot}6$; $K_c = 31{\cdot}2$; that value for hydroxyl ($K_{(OH)} = 1{,}356$) was taken, which satisfies the equation for water. The closeness with which the equation is satisfied for all the other liquids which contain the hydroxyl group is indeed remarkable; the author was subsequently led to examine the aldehydes, acetones, &c., and met with equal success, and draws some important conclusions as to the operations concerned in chemical combinations.

In the case of solids, and of such liquids as contain no atom groups, the atomic capacities seem to be in the ratio of the atomic weights, so that the formula takes the simple shape

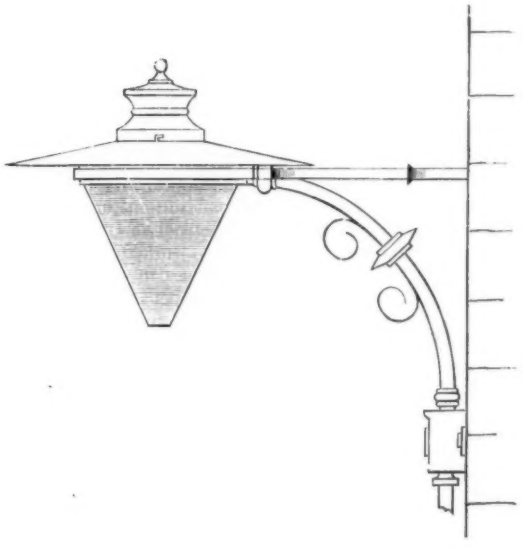
$$K = k\,D,$$

where $k = K_h$. The agreement between observed and calculated values is here again so close that it can scarcely be attributed to chance. These experiments of Mr. Thwing represent a great deal of hard work, and their results form a most valuable addition to our knowledge of the nature of dielectrics and the general processes of chemical constitution.

THE "GOLDSTON" SYSTEM OF SERIES INCANDESCENT LIGHTING FOR PUBLIC STREETS.

The "Goldston" system is designed to accomplish the maintenance of the continuity of the entire lamp circuit in a manner, it is believed, more practical, simple, and efficient than it has been done before, the circuit being automatically closed at the junction between the lamp and the main "series" line should the lamp be out of order.

Referring to the drawing, it will be seen that the base-board, which is of teak and surmounted by a porcelain insulator, supports two pendant V-brackets, which are connected directly to the main "series" line, and they are each provided with spring lever contact-makers; to these are attached the leading wires of the lamp, the wires being maintained in a state of tension by the lamp being drawn away, so that the



contact makers are held in such a position as to compel the current normally to pass through the lamp, but upon the tension of either or both of the wires being relieved by breakage of the wire terminals, or fracture of the glass or other means, the spring lever contact makers come together and form a short circuit across the lamp, and thus keep the main circuit intact.

In the mechanism which carries the lamp, if a failure takes place the action is instantaneous, and the continuity of the circuit is not even disturbed for an instant, as there is a momentary "arc" set up at the points of breakage when the current is on, on account of its "high tension;" so that although the mechanical continuity of the conductor be broken, yet there is no rupture in the electrical continuity, as the arc being maintained for a moment, gives a spring contact ample time to act. The "arc" formed is instantly cut off, and cannot travel, the contact makers, by virtue of their parallel motion, maintaining a perfectly electrical and sound connection.

By the simple and purely mechanical means employed the action is equally effectual whether anything happens to the lamp whilst the current is on or (in the daytime) before starting the current, and it need hardly be pointed out that these are essential requirements, and that any arrangement that cannot fulfil both must be unsatisfactory.

If the lamp "gives out under current" an "arc" is instantly set up within the bulb, which rapidly destroys the leading wires where they pass up through the glass seal. As they give way contact makers are released, and immediately make contact with each other, which they have a normal tendency to do. Should the lamp, however, be destroyed when the current is not on, by concussion, or by the breakage of the bulb at the crown or at the leading wires at the seal, such breakage causes the above action to take place in a precisely similar way by the release of the same contact makers.

In renewing the lamp it is only necessary to insert its lugs in terminal clamps provided on the flexible conductors below the contact pieces, and to screw them tightly up, the lamp is then drawn bodily away by means of a stretching screw and nut attached to a hoop under the lamp, and the contact makers being thereby separated, the current passes through the lamp and it is thus lighted; by merely slackening the nut the lamp can be short-circuited and extinguished at any time. This arrangement also serves as a hand-switch if so required.

The parts of the mechanism are few and substantial, and the contact makers have ample substance and surface. The conductivity from main line to lamp is not dependent upon any movable joints, the flexible conductors from the lamp terminals after passing through the contact pieces being connected directly to the brackets and main circuit.

As there is no "fuse," or anything of the kind to replace on this system, it is obvious, upon the lamp being renewed, the device is thereby re-set, consequently its short-circuiting action can be repeated.

All parts are interchangeable, thus saving both time and trouble to users. Should the contact surfaces ever become impaired, they can easily be removed and replaced without interference with any other part, and in the event of their ever being destroyed they can be renewed at the cost of a few pence each.

The whole of the parts are nickel plated, not for appearance, but for protection against atmospheric influences.

Lamps used in this system can be of any candle-power, from 8 upwards, and the same device can be used for any power without alteration, as the cutting-out operation is independent of the difference of potential at the terminals of the lamp controlled. They should be worked with a constant current from 5 to 10 ampères, and can also be used on existing alternating high tension mains as well as on series arc light circuits.

The apparatus is designed for use in a street wall bracket fitted with a *Webber undershade*, which has a diamond cut surface, for diffusing the light on the principle of the Trotter dioptric lantern. (See illustration.)

BERSIER'S STEERING COMPASS.

The traditional order, "Don't Talk to the Man at the Wheel," that some of our readers have seen posted up on steamers, is upon the point of becoming useless, thanks to a very recent invention of one of our most distinguished naval officers, Lieut. Bersier. This invention is called the steering compass.

This instrument, in fact, permits of dispensing with the man at the wheel. It is the compass, says *La Nature*, that in this system directly actuates the rudder, so as to keep the ship in the proper direction.

Did the use of this new apparatus present no other advantage than the doing away with the man at the wheel, the result, although original and curious, would be relatively of slight importance. But the special merit of this method of steering is the great precision that results from it, thanks to the substitution of the most absolute automatism for the action of the brain of man, which sometimes becomes weary or distracted.

The problem of the automatic steering of ships has often been proposed, since it is an attractive one; but the difficulty in the way of its solution has been the necessity of giving the very delicate and sensitive card of the new compasses its full liberty, while, at the same time, utilising the elementary rotations of the sides of its box with respect to the card, that is to say, the lurches of the ship, in order to correct such lurches by means of the rudder. In order to govern this part, then, it was impossible to think of utilising the steering power of the card; in a word, the latter could not be touched. It is this that explains the want of success of all the attempts made up to the present to devise warning compasses, that is to say, compasses to signal the deviations of a ship to a distance. In such instruments, a magnetised needle was flanked by two stops forming electric contacts against which it struck, on becoming disturbed.

As our readers well know, a mariner's compass consists of a glass-covered cylindrical box suspended in gimbals in what is called a binnacle. At the centre of the bottom of the box rises a rod that carries an iridium pivot. A light paper disc balanced upon an aluminum circle carries eight parallel magnetised needles. Such is the card, which weighs 375 grains, at the most, in the large patterns. Its circumference is graduated in degrees from 0 to 90 in each quadrant, starting from the north and west points, on the one hand, up to the east and west points on the other. At its centre there is a sapphire which rests upon the point of the pivot. The position of the needles below the disc, to which they are attached by silk threads, assures the horizontality of the card. The feeble magnetic momentum that so light a card may have prevents any stress being exerted upon it under the penalty of disturbing it completely.

Lieut. Bersier, as long ago as the year 1888, thought of employing the electric spark of the Ruhmkorff coil to unite a point of the circumference of the card and two semi-circular plates insulated electrically from each other and the sides of the box that they covered. Some experiments successively carried

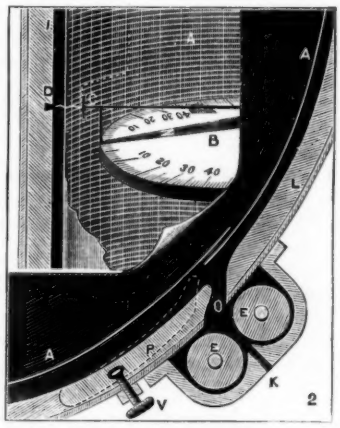
A, A, band of paper upon which the variations in the route of the ship are inscribed; B, rose; C, bridge of fibrine placed at the north point of the card; D, circle of metal divided into segments corresponding to the signals; L, cylindrical ebonite guide of the band of paper.

Fig. 1.—General View of the Steering Compass.

on upon a torpedo boat and a large cruiser, were arrested at this epoch by the absence of electric wiring upon many ships. The operation of the coil, in fact, can be practically assured

only by a small derivation from a dynamo to the exclusion of electric batteries. Things are now much changed. Upon all modern ships a few ampères are as easily taken from a general circuit conductor as water is from a cock. So the steering compass will be henceforth easy to instal. It operates as follows:—In a room located at a few yards distance from the best compass on board is placed a Ruhmkorff coil supplied by a mean current of from 2 to 3 ampères. The induced current of this coil, through a flexible wire, reaches the pivot of the compass, whence it passes to the aluminium capsule that carries the sapphire, and follows an aluminium wire, forming a radius of the north pole of the card (fig. 1).

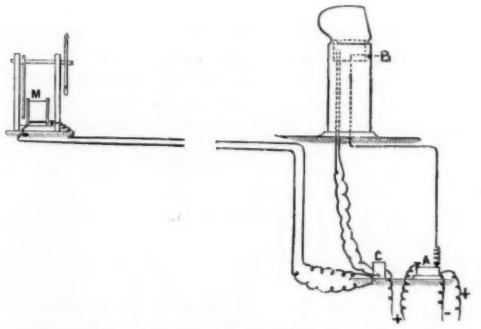
According as the ship is to the right or left of its course, the current leaps in a spark of about an inch from the north point to the right hand or left hand plate of the box and flows, at a few yards therefrom, into one or the other of two electro-magnets, which close the circuit of a small



A, band of paper; B, card; C, fibrine bridge; D, circle of metallic pieces set into ebonite and each corresponding to a signal; L, paper guide; O, slit for the introduction of the paper; E, E, rubber rollers for the introduction of the band of paper; V, regulating screw.

Fig. 2.—Explanatory Details.

150 watt motor, in order to cause it to revolve to the left or to the right. The shaft of this motor is keyed upon that of the rudder motor. One merely replaces here the muscular strength of the pilot without in anywise changing the



A, Ruhmkorff coil; B, compass; C, circuit closer; M, motor actuating the rudder.

Fig. 3.—Diagram Explanatory of the Installation of the Registering Compass on Shipboard.

already existing parts of the ship. This installation is therefore simple and inexpensive (fig. 3). The box of this compass has been under trial for two months in a squadron and the experiments have proved a perfect success. The absolute indifference of the card to the electric spark was particularly exhibited, and it was found possible, as the report of the trials proves, to steer within a fraction of a degree or thereabout. Such indifference of the card evidently results, in the first place, from the fact that the induced current employed has an intimate intensity—it is alternating. Moreover, certain precautions are taken as regards the leaping of the spark. The coil and the electrodes are at a distance from the compass. Experience shows that it is sufficient for them to be at a distance of five yards therefrom in order to obtain the best result. Thus the induced circuit of high tension, and consequently of relatively difficult insulation, is not ten yards in length. The number of the coil is so selected as to prevent all accidental losses.

Lieutenant Bersier has patented this new instrument under the name of a registering governor. When the apparatus acts as a register, the box is higher and its sides are covered with a band of paper which receives from a clockwork mechanism an ascensional movement of three inches in four hours, a length of time that constitutes the duration of one point (Fig. 2). The electric spark pierces this paper in its travel from the north point of the card to the plates. The result is that every lurch of the vessel, however short be the duration of it, is registered. Thus responsibility can be clearly established in the case of running foul of another vessel.

Finally, the box of the steering compass, provided with six plates, for example, instead of two, each being connected with a distinct Geissler tube placed in front of the man at the wheel, serves, under the name of automatic transmitter of course orders, to steer by hand from any point whatever of the ship with a compass placed no matter where. It is this instrument that has been tried in a squadron, and two new specimens of which are now in course of construction for our navy by M. Postel-Vanay. The solution of this problem was necessary, since upon our new ships, the binnacle compass, always placed too near masses of iron, possesses no sensitiveness, but "sleeps," according to the technical expression. A method of steering with the standard compass placed under the best conditions possible became necessary, and it became necessary, too, to find a means of sending its indications to a distance. Experience has proved that six or eight of these indications are more than adequate to permit of effecting all the changes of route and of steering with a precision hitherto unknown. Only a mariner can appreciate this point, which is important because of the great simplification that proceeds from it. As long ago as 1888, Lieutenant Bersier steered with four signals only, which, through the rapidity with which they succeeded each other, gave an accurate idea of the velocity of rotation of the ship. The manner of effecting the changes of route with this instrument is, in truth, interesting. A simple revolution of the cover of the compass by hand, carrying along the plates with it, is immediately followed by an identical rotation of the ship.

The edge of this cover, moreover, is graduated like the card itself, and in order to hold any route whatever, North 25-East, for example, it suffices to place in the axis of the vessel, opposite an appropriate index, the division 25, comprised between the North and East of the cover. The pilot then takes the new route without even being aware of the fact, in thinking that he is correcting a lurch. The straight route or zero indication can be transmitted to him only when there is an absolute superposition of the graduation of the cover and of that of the card. The spark then leaps both to the first plate to the right and the first to the left. The slightest lurch has the effect of making it leap to only one of them.

The entire precision of the apparatus that we have just described rests upon the sensitiveness of this zero signal.

Upon the whole, the following are the advantages that large steamers must derive from the use of these new apparatus, they can make but one course, since the box and the coil are always single: with great precision, and, consequently, security and economy in navigation. At present, steering is done within about one or two degrees, that is to say, with a lateral deviation of 12 miles for a day of 480. With the apparatus under consideration, the lateral deviation would be annulled, as the steering is done within a fraction of a degree. Finally, the steering would be done with the best compass on board, and this in many cases, in which the common compass is defective. All this is of value, especially in foggy localities, where astronomical observations cannot be taken. To such advantages must be added that which gives a better estimate of the route obtained by the registering.

The foregoing translation is taken from the *Scientific American*.

THE WORKING EXPENSES OF ELECTRIC AND CABLE RAILWAYS.*

I.

Nearly a year ago we gave in these columns some analysis of the working expenses of electric and cable railways and tramways in this country. The figures supplied were correct as far as they went, but more extensive data are now to hand, and we propose to present a series of tables which ought to be very instructive and interesting to all who are now considering the subject of electric and cable haulage from a commercial point of view. There are included the accounts of various companies for the year or half-year ending June 30th last, which have recently been issued. At present, also, we have the benefit of the statistics for nearly eighteen months of the Liverpool Electric Railway, which a year ago had not long been started. The other lines dealt with are the City and South London Electric Railway, the Birmingham electric and cable lines, and the Edinburgh Cable Tramways. Unfortunately there is no electric trolley wire tramway running along public streets and roads in England in regard to which full details are obtainable, but we shall reproduce the incomplete figures recently given by Mr. Dickinson as to the new South Staffordshire electric line. It is also to be regretted that the London Tramways Company have not yet published separate accounts of the expenses of their splendid cable road at Brixton.

The details below have been amplified so as to present the matter in the clearest light, and from different points of view. In the present state of matters in the field of traction this is most necessary, for we are convinced that the wide adoption of mechanical power for tramways and light railways cannot be much longer delayed.

Dealing first with electric railways, we take the elevated line in Liverpool. A year ago the latest report of the company covered only 17 weeks' working, and the locomotive power was supplied at a contract rate of 4d. per train mile. Two half-yearly reports have been issued since, and the latter of these is specially valuable, since during the six months with which it deals, the company were working the whole undertaking themselves, and knew exactly what it was costing. They had been so well satisfied that they relieved the contractors before the expiry of their term, and it was to find, joyfully, of course, in the circumstances, that the contractors must have had a profit out of their 4d. per train mile. We make no allusion here to the structure or equipment, as these are now well known. A careful study of the following tables is commended. They extend back to the opening of the line, and in the first two half-years the contract rate was in force for motive power. Apparently this included car repairs. In the Tables shillings and pence are omitted from the totals.

Liverpool Overhead Electric Railway.

Table I.—Per Train Mile.—Pence.

Half-year.	Maintenance of way, works, and stations.	Locomotive power.	Car repairs and renewals.	Traffic expenses.	General charges, taxes, &c.	Total expenses.
June, 1893 (17 weeks)	—	4·00	—	7·05	4·36	15·41
Dec., 1893 ...	1·7	4·03	—	5·32	2·48	13·53
June, 1894...	1·69	2·88	·38	5·68	2·89	13·52

Table II.

Half-year.	Expenses per train mile.	Receipts per train mile.	Per cent. of expenses to receipts.	Total expenses.	Total receipts.	Miles run.	Passengers carried.
				£	£		
June, 1893 (17 weeks)	15·41	27·23	56 59	6,990	12,352	108,85(	1,370,742
Dec., 1893 ...	13·53	18 67	74·87	13,732	18,342	243,589	2,475,639
June, 1894...	13·52	18·1	74 69	14,947	20,012	265,349	2,861,437

The great reduction in the cost of motive power as soon as the company dropped the contract rate will be noted. The items of traffic expenses, general charges, taxes, &c., which show an increase, bringing up the total, per train mile, to the same figure as that of the previous half-year, are to a large extent, independent of the kind of motive power used. As the amount of traffic increases on the railway the expenses per mile run will, with proper management, go down.

Let the preceding figures now be compared with those that follow. The City and South London Railway Company, fortunately for purposes of comparison, state their accounts in exactly the same way as the Liverpool Company. More than this, the weight of the train, with all seats occupied, is in each case almost the same. The point of difference is, that the Liverpool train consists of two long cars with the motors mounted beneath them, while the London train is of three shorter cars with a separate electric locomotive. The following shows the details since the opening of the line :—

City and South London Electric Railway.

Table I.—Per Train Mile.—Pence.

Half-year.	Maintenance of way, works, and stations.	Locomotive and generating power.	Carriage repairs.	Traffic expenses.	General charges, taxes, &c.	Total.
June, 1891..	·53	9·06	·5	8·82	2·44	21·35
Dec., 1891 ..	·63	7·89	·46	8·1	2·66	19·74
June, 1892...	·56	7·67	·54	7·52	2·89	19·18
Dec., 1892 ...	·43	7·11	·47	6·78	2·44	17·23
June, 1893...	·5	6·48	·53	6·39	2·6	16·5
Dec., 1893 ...	·6	6·23	·46	6·17	2·35	15 81
June, 1894..	·59	6·22	·41	6·07	2·51	15 82

Table II.

Half-year.	Expenses per train mile.	Receipts per train mile.	Percentage of expenses to receipts.	Total expenses.	Total receipts.	Miles run.	Passengers carried.
				£	£		
June, 1891...	21·35	27·02	79·02	15,521	19,637	174,435	2,412,343
Dec., 1891 ...	19·74	25·75	76·66	15,516	20,244	188,666	2,749,055
June, 1892...	19·18	27·33	70·18	15,098	21,520	188,944	2,813,162
Dec., 1892 ..	17·23	25·36	67·94	15,390	22,653	214,417	3,217,602
June,1893 ...	16·5	25·54	64·5	14,964	23,159	217,664	3,146,656
Dec., 1893 ...	15·81	23·66	66·82	14,762	22,093	224,101	3,093,351
June, 1894...	15·82	25·6	61·8	14,990	24,235	227,363	3,383,154

It will be noted that it is in the item of motive power that the London expenses chiefly exceed those in Liverpool. Whether this partly arises from having a separate locomotive or not we cannot say, but undoubtedly the steep gradients and sharp curves which distinguish the London line have something to do with the matter. The traffic expenses, which also exceed those in Liverpool, include the cost of hydraulic power for the passenger lifts at each station, while of course there are no such lifts on the Liverpool line, which has the advantage of not being buried deep in the bowels of the earth. The traffic on the two lines is very differently distributed, as the London line is little over three miles in length, while that in Liverpool is about three times as long. Other things being equal, this should be to the advantage of the London line, but then it cost about four times as much per mile to construct as the Liverpool railway. The present dividend on the ordinary stock is in each case 1 per cent. It will also be noted how the position of the City and South London is improving as the traffic increases, the percentage of expenses to receipts having gradually fallen from 79 to 61¾. What this company requires is the extension of its line northward to Islington, for which it already possesses Parliamentary powers. At the recent meeting of the shareholders, the chairman mentioned that in his opinion an extension only to Moorgate Street would enable the directors to pay a dividend of 5 per cent. on the ordinary stock. This being the view, the directors will doubtless proceed with the extension as soon as possible. Capital is rather hard to get just now, but the prospects from the extension of the railway are good. The great bulk of the traffic on the line at present is in the morning and evening, from and back to

* The *Railway World*.

the southern suburbs. But let the company run right across the City to the north, and an all-day traffic would be secured.

We here take leave for the present of electric railways, which in the nature of things can be worked more economically than can ever be the case with electric tramways. Let us pass to the only electric street line of which full accounts are published, that is the unfortunate accumulator tramway in Birmingham. This section of the Birmingham Central Tramways Company's system is surpassing even our worst forebodings. From the time it first started, over four years ago, we were dubious about the maintenance of the accumulators, and as time has passed things have gradually gone from bad to worse. It will be fresh in the minds of all that the directors of the company, disgusted with the expenses of maintaining the batteries, applied, but applied in vain, to the Corporation of Birmingham to erect poles and wires along the Bristol Road with the object of running the tramway on the trolley wire system. There is no doubt that in the locality in question the American method of working would be a financial success, but the local objections to the poles and wires in this residential locality proved insuperable. The directors have adopted the policy of keeping down the mileage run with the object of raising the receipts per car mile, so that if possible they might be equal to the terrible expenses. In this they have not been quite successful. It seems that now, reluctant as we are to come to the conclusion, demonstration has reached the point of absolute proof that, as in America, accumulators for traction purposes will have to be "dumped on the scrap pile." If a storage battery is ever produced which can stand the intense strains of traction work, it will be greeted with open arms by the tramway world. Meanwhile, there is nothing for it in the way of electric traction but the poles and wires. The following tables exhibit the lamentable career of the secondary battery on the Bristol Road in Birmingham :—

Birmingham Electric Accumulator Line.

Table I.—Per Car Mile.—Pence.

Year ending	Electric haulage.	Machinery.	Car repairs.	Traffic expenses.	Permanent way and buildings.	General charges.	Total.
June, 1891	5·15	·29	1·93	1·34	·14	1·05	9·9
1892	5·88	4·03	1·11	1·44	1·72	1·21	15·39
1893	6·1	4·5	·99	1·9	1·63	1·43	16·55
1894	6·0	3·71	·67	1·74	2·21	2·53	16·86

Table II.

Year ending.	Expenses per car mile.	Receipts per car mile.	Percentage of expenses to receipts.	Total expenses.	Total receipts.	Miles run.	Passengers carried.
				£	£		
June, 1891	9·9	15·15	65·35	5,711	8,732	138,396	1,144,718
1892	15·39	13·25	116·15	12,102	10,422	188,760	1,382,997
1893	16·55	16·38	101·04	9,721	9,623	140,993	1,257,399
1894	16·86	16·79	100·42	9,774	9,734	139,123	1,303,833

It will be observed how the items of electric haulage and machinery have gone up, though there is a slight falling off in the year just ended. Perhaps the improvement may be due to a proportion of new accumulators having come into use. The general charges have, however, become strangely high. If these can be cut down possibly next year we may see the line paying its way, provided, of course, that the directors do not give any increased facilities to the public by increasing the mileage run.

An important explanation as to the accounts must be here made. Part of the lines of the Birmingham Central Company lie outside the city boundary. This part is maintained by the company themselves, while within the city boundary the corporation carry out the work of maintenance, and charge the company therefor. In the past the company have always entered the corporation charges for maintenance of the lines within the city, and the company's expenses for maintenance outside the city as one item in the working accounts of each of their four departments. The company have, however, all along contended that the corporation charges were excessive. In the year just past these charges again advanced by a sum of £1,729 14s. 11d., reaching, in all, £8,699 15s. 11d. In the report for the year ending June 30th last, the directors, instead of apportioning this heavy item as usual over the working accounts of the steam, horse, cable, and electric departments, have transferred it in one lump sum to the revenue account. The result of this would be that no proper comparison could be made between the working accounts of the past year, as published, and those of previous years. We have, however, through the kindness of the secretary of the company, been furnished with the details of these corporation charges for each of the four departments, and in the above tables we have included the proportion of the corporation charges debited to the electric department. A real comparison with previous years can accordingly be made. The item affected is permanent way and buildings. In the working accounts the total sum spent by the company under this heading on the electric line only amounted to £28 6s., working out at ·05d. per car mile run. The corporation charges, however, came to £1,254 13s. 9d. The total expense under the head of permanent way and buildings thus works out at 2·21d. per car mile—a sum exceeding that of any previous year. We cannot, of course, go into the question of the justice of the corporation charges. All that need be said is that the company are sufficiently indignant, but, that even though there were no such charges at all, the expenses of the electric department would be totally out of the question.

Another consideration has now to be looked at, and it is one which, as far as we know, has not been dealt with by anyone considering the accounts of this company. It does not affect to any great extent the comparison between one year and another, so far as the Birmingham Company is concerned, but it does affect the comparison with other companies. In the accounts of most tramway companies all items of expenditure in the carrying on of the undertaking are included under the heading of "Revenue Account." In the case of Birmingham, however, the practice is to give under the heading "Working Accounts" all the expenditure included under the six items in the preceding tables. These are given separately for each of the four departments. But the following items are not, as with other companies which have only a horse department, included under the head of "general charges," namely, directors' fees, directors' travelling expenses, managing directors' remuneration, secretary and manager and his staff, and auditor's fees. Clearly, all these items must be taken into account to arrive at the total working expenses. The other matters included in the "revenue account"—rents, interest on debentures, and so forth—are as clearly outside the sphere of working expenses. The fees and salaries above referred to, though not apportioned among the four departments, can easily be allotted by finding at how much they work out per car mile, taking the grand total of miles run by the whole of the four departments. That grand total for the year ending June 30th last amounted to 2,759,531 car miles. The fees and salaries in question stood at £2,326 5s. 7d. This is equal to ·2d. per car mile. For previous years we have worked out the figures in the same way, and the following table shows the results :—

Corrected Birmingham Expenses.—Electric Line.

Per Car Mile.—Pence.

Year ending.	Total as in preceding table.	Additional expenses.	Grand total.	Percentage of expenses to receipts.
June, 1891	9·9	·27	10·17	67·13
1892	15·39	·22	15·61	117·81
1893	16·55	·25	16·8	102·56
1894	16·86	·2	17·06	101·61

After this somewhat toilsome journey the reader will have got down to bed rock as to the actual total working expenses of the Birmingham electric accumulator tramway. The figures are clearly set forth in the column headed "grand

total." It is with these figures and not with any others that comparison must be made when looking at the total working expenses per car mile of other tramway companies. They are a melancholy array, and perhaps even more so, as catching the apprehension more readily, are the percentages given in the last column. The favourable state of matters in the first year, of course, arose from the fact that all the batteries were then new.

Before leaving electric traction, we may here repeat the figures which Mr. Alfred Dickinson recently submitted to the Institution of Civil Engineers as to the South Staffordshire electric tramways. The statistics do not give all the expenses, but are confined to the charges for running and repairs. As the reports of the company do not give the expenses for the electric line separately, Mr. Dickinson's figures are all that are available. He gives a comparison with the corresponding items for the Birmingham cable line, and for several steam lines. The following are the cable and electric figures :—

Per Car Mile.—Pence.

Tramway.	Wages.	Fuel.	Stores.	Water and gas.	Sundries.	Repairs.	Total.	Miles run.
Birmingham Cable ..	1·54	·6	·19	·03	·05	1·81	4·22	641,161
South Staffs. Electric ...	1·93	·48	·43	·08	·06	1·08	4·06	262,694

The corresponnding items on the steam lines vary between 6·79d. and 8·57d., while on the Birmingham accumulator line the total of the same items is put at 11·59d. We are very glad to see that the South Staffordshire electric figures are so low. They form the first downright solid details for this country of a trolley wire street tramway, where the dynamos are driven by steam engines. It is to be hoped that the future will not see much change for the worse, but it cannot be doubted that the item for repairs (which does not include repairs to the track) will, as years go on, become considerably higher. It is obvious that a sum very little above a penny per car mile for repairs to stationary engines and boilers, dynamos, motors, poles, overhead wires, and cars, must be exceeded in the future. At present all these appliances are new, and American experience has shown that, with an electric tramway, the first year is the best so far as expenses are concerned.

ELECTRIC ILLUMINATION OF AN ORANGE.

Mr. C. Limb, preparator to Prof. Lippmann, at the Sorbonne, has shown us (*La Nature*) a beautiful lecture experiment which we shall describe.

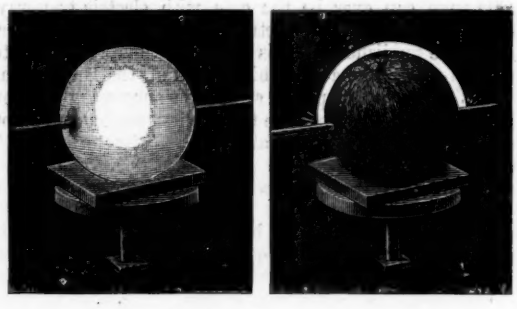
Upon an insulated support there is placed an orange, into whose poles are inserted movable needles which, through the intermedium of sleeves, are carried by glass standards. One of the needles communicates with the external coating of a strong battery of Leyden jars charged by means of a Holtz machine. After a sufficient quantity of electricity has been accumulated, one of the arms of an exciter is applied to the needle, while the other is placed near the interior pole of the jars. A strong spark bursts forth, and at the same time the orange becomes illuminated with a bright red light that gives it the aspect of a globe of fire (fig. to the left).

If, in a repetition of the experiment, the orange be so turned that its axis shall be at right angles with the direction of the needles, the discharge will pass around it without illuminating it (fig. to the right).

This latter phenomenon is explained by the difference of resistances of the fibres in the various directions. It is not an isolated one, but, on the contrary, constitutes a general property of ligneous bodies.

The difference in the result of the two experiments shows that the greater part of the discharge passes into the interior of the orange. In fact, if it passed through the skin, or even immediately beneath it, the position of the needles would be indifferent.

It appears probable, therefore, that the light is produced in the interior of the fruit and entirely traverses the skin, which thus shows itself more transparent at the level of the spark than would have been believed at first sight.



The discharges in the direction of the axis damage the orange but slightly. On the contrary, when, by exception, a spark traverses the fruit in a perpendicular direction, it tears it in pieces and destroys it. The experiment succeeds nearly as well with other fruits, which become illuminated with various tints.

STANDARD UNITS FOR ELECTRICAL MEASUREMENT.

I.

Probably no committee of any learned society has done better work than that appointed by the British Association for the purpose of verifying and issuing practical standards to be used in the measurement of electrical resistance. Appointed in 1861 by the British Association at the suggestion of Lord Kelvin (then Prof. W. Thomson), it has not ceased from its labours up to the present time, when its functions seem to have merged into those of acting as an advisory body to the Standards Department of the Board of Trade, who, by their electrical department, have vested rights first conferred by the Weights and Measures Act, 1889, and now exercised in a careful manner.

However accurate the determinations of the B.A. Standards Committee, as it was shortly called, may have been, its members could have no power to insist upon the adoption of any unit to which they might give a name and denomination. The value of the work done by this committee has, however, been fully recognised by the Board of Trade, and its periodical reports have been accepted by physical and scientific men all the world over as giving the most exact and careful results which could be obtained in the preparation and maintenance of a system of resistance units which, although they might not truly be concrete representations of the abstract values they professed to represent, still had the merit that a unit, as certified by the *fiat* of the committee, would be capable of reproduction and duplication in a remarkably exact manner. This must be largely attributed to the personality of many of the members of the committee who have, since its first appointment, been associated with its work, and to others who, although of later date, have during recent years taken a most active part in the practical investigation inseparable from its work. While this is true, there is the additional importance which surrounds any work of a more or less international character. This course was practically adopted at the suggestion of Prof. Von Helmholtz, and his proposal that the unit of resistance finally adopted by the B.A. Committee, and therefore probably that which represented in concrete form the legal ohm standard of this country, should be made the international unit, was discussed at the Edinburgh meeting of the Association. An international decision was then reached, and adhesion to that finding was informally given by representatives of the United States of America, France, and Germany, while it was con-

fidently stated that Austria and Italy would also agree to the arrangements then made.

When the separate units are dealt with, we shall examine somewhat critically the mode by which their values have been arrived at, the dimensions given to them, and the concrete form in which they are realisable at any time; but as the resistance unit was the first to receive attention, and is the most important of the three most commonly used practical units, it is fitting to preface any remarks upon standards generally by an acknowledgment of the work of the B.A. Committee.

It will be necessary to digress somewhat from the proper order of thought to deal with the latest phase of the unit standard's question. We have already very briefly sketched something of the work of the one body, which has, so far as this country is concerned, carried out all the work in connection with determinations of resistance values, and the embodiment of such values in a form which would serve for future comparisons and for general use. In many cases, work was done either personally by members of the Electrical Standard's B.A. Committee, which could not be said to be done officially by the committee, or independent experiments were engaged in by investigators who were not included in the list of members. The results were submitted to the Royal Society in the majority of instances, and a brief account of the same was embodied in a report to the committee at the yearly meeting of the association, while descriptions of the experimental methods adopted and apparatus used often found their way to the Physical Society's Proceedings, where they are more accessible to the public than in either the *Trans. Royal Society* or the B.A. Reports.

Notwithstanding the large amount of careful work done, and the high standing of those engaged upon the work inaugurated by the committee, it was open to any member of the public to use any unit for which one might have a fancy; the illegality of the so-called legal ohm of the 1884 Paris Congress was a standing joke. While telegraphic work formed the principal, if not the only practical service to which electricity was put, the public at large had little interest in electrical units. These formed subject for discussion by physicists, and whatever the value attached to them might be, it had but small commercial importance. The telegraph companies in the early days were quite content to adopt as their unit of resistance the standard proposed by the B.A.; it was found that "great inconvenience had been felt by the absence of any generally adopted unit for the measurement of electrical resistance, and it was thought that the influence of the British Association might be successfully exerted to procure the adoption of a common standard."* When these words were written it was considered that the conditions were especially favourable for some concerted action in this direction, for although methods of observation had then not been brought to great perfection, no local units had as yet taken very deep root. The main objects in view were twofold, that whatever basis might be adopted for the unit, such unit should be represented by *one particular standard constructed of very permanent materials, laid up in a national repository*, and that the committee would endeavour to devise some plan by which such copies of the actual material standard adopted might be easily procured at a reasonable cost. As will be seen, more than three decades have elapsed before the first object of the committee has been fully accomplished, it has been left for another generation to carry out in its entirety the hopes of those who first met with the objects mentioned. The second proposal has, however, been closely adhered to, and everyone interested in electrical science is familiar with the well known form of the B.A. standard ohm. The concrete realisations of the determinations of the committee have had a moral weight which cannot be exaggerated. One reason for this was that the time, labour, and money required for the investigations could hardly have been expected to be given by any one person, and in researches of the kind the value of the co-operation secured by the committees of the Association was especially evident. In 1864, Mr. Varley promised that the B.A. unit should be used for resistance measurements of the Electric and International Company, while it was also employed to express the tests of the 1865 Atlantic Telegraph Cable. Sir Charles Bright also gave adherence to the unit on behalf of the British and Irish Magnetic Telegraph Company, and the Indian Telegraph Department also introduced the unit. In all these cases the consent was optional, but a change came over the aspect of events when years had gone by, the telegraph was firmly established, but messages were paid for by their length, and not by a rate fixed according to the resistance of the lines over which they had to be sent. Telephony did not materially increase the importance of the resistance unit, but when this application was immediately followed by practical forms of incandescent lamps, by the storage battery transformer, and dynamos of high efficiency, the supply of electrical energy became an established business, and then legislation stepped in. In defining the unit quantity of electrical energy, it was necessary to start with the ampère and ohm. The ampère had always been 10^{-1} C.G.S. units of current, and Lord Rayleigh had shown most exactly what this current was, expressed in terms of silver deposition from a specified solution of a silver salt. The absolute measure of the ampère is also comparatively simple. Force could be easily measured, so could length, so that $M^{\frac{1}{2}} L^{\frac{1}{2}} T^{-1}$ was capable of very direct and accurate measurement. The same argument applied to the ohm, as Kelvin showed in 1863, using the first method of Weber, and as Prof. Jones has lately demonstrated when adopting the Lorenz method.

As the current unit remained the same, any variation in the concrete determination of the velocity, $L T^{-1}$, taken as the absolute unit of resistance correspondingly affected the unit volt.

* B.A. circular addressed to foreign men of science, 1862.

THE RAND SYSTEM OF UNDERGROUND RAILROAD.

The *Electrical Engineer* of New York states that over 440,000,000 journeys were made on the elevated and surface (tram) roads of Manhattan Island in 1892; this, too, on North and South lines only. This is taken as evidence that New York City is capable of furnishing passengers sufficient to guarantee the fixed charges on a first-class four track underground line. The peculiar geography of Manhattan Island which has a maximum breadth of about 2½ miles and is arranged, so far as regards residence and business, in what amounts to practically two extremes joined by tram and railroads, is probably enough to warrant this conclusion. In this respect New York is almost unique. It is all up-town or down-town and any suburban resident who elects to go home other than northwards must cross the bridge or ferry to Brooklyn, or ferry to the Jersey side. Hence the concentration northwards. Without the necessity for crossings any north and south line seems particularly suitable for a system of electric propulsion. In the Rand system this is proposed for a line under Broadway and the Boulevard between the battery and Fort George, a distance of 10½ miles. This length it is proposed to divide, as regards power stations, into three, about three miles apart, which will feed the main conductors.

The Rand system of tunnel is simply a large rectangular excavation divided vertically by a row of columns and horizontally by cross girders carrying longitudinals and floors. There are thus four longitudinal tunnels of square section, 11 feet × 11 feet, with each a central overhead conductor fitted with a sliding contact and rail return for a proposed 1,000-volt current. The assumption is made that 100 five-car trains will handle the Broadway traffic. The four car trains of the Exhibition or Intramural line were able to develop a speed of 32 miles if required, they had an average of 42 H.P. per train, and it is inferred that 75 H.P. should deal with the underground trains. The one hundred trains would therefore require 7,500 horse-power at the dynamos. Allowing 31 stations with 100 lights each, and 75 lights per train, we have a total of 10,600 lights requiring 1,060 H.P.

Ventilation is proposed to be effected by shafts midway of the stations fitted with 6 feet fans capable of dealing with 32,000 cubic feet per minute each fan. Forty fans at 5 H.P. each adds a further 200 H.P. The total of 9,760 H.P. is to be yielded by plant of 5,000 H.P. at each of the three stations in the shape of a pair of 2,000 H.P. dynamos and one of 1,000 H.P., and these being on the Hudson River would obtain fuel and ample water at the lowest rates.

The tunnel roof is placed 8 feet below surface, giving a depth of 18 feet to the "slow" upper platforms, and of 30 feet to the "fast" platforms. Above 59th street these would be reduced to 13 feet and 25 feet respectively. As an elevator there is proposed a rubber covered iron travelling belt with a hand rail equal to 6,000 persons per hour. We are not told how its speed will suit the aged and the young alike. If slow, however, the active could walk forwards also. Anyhow, if always moving it will be better than the perfunctory manner in which the elevators are worked at the Monument Station of our City and South London line, often appearing to have stopped for the day. That passengers do dislike depth and will undoubtedly shun a line as far as they can which neglects its elevators is axiomatic, and we think that if not too slow the continuously moving belt will be a success if

constructed. In November, the citizens of New York will be called on to vote for some system of underground communication and the Rand system is one of the proposed schemes. It has nothing extravagant in conception. It is not unlike the scheme of five years ago, promoted as the London Central Subway Railway, but differs in being double storeyed; and, in the greater depth below surface of the roof, the London scheme supposing simply a steel roof to serve the double purpose of roof to the railway and street surface, all pipes being put into lateral galleries. The scheme would have passed had it not been for an interested and not over scrupulous opposition, for there were no engineering difficulties and no deep platforms; and, if we remember rightly, there was provided fully 3,000 H.P. for a two-track line between St. James Street, Piccadilly, and Holborn Circus, an amount relatively much greater than is being proposed for the Rand scheme of four tracks, but we believe expressly provided in anticipation of an extravagant power estimation from the opposition. This was indeed done, but with the most extravagant assumptions as to all the trains starting at once and so on; even Sir Frederic Bramwell was unable to stretch the power required to the amount provided by the promoters.

We see no reason why, if adopted, the Rand scheme should not prove a success. So far as we can learn the surface geology of Manhattan Island, the system is more suitable than that of the circular bored tunnel on the Beach system, or, as here termed the Greathead system, and any deeply buried line is quite out of question for New York's main artery of travel.

THE FRENCH SOCIETY FOR THE ENCOURAGEMENT OF NATIONAL INDUSTRY.

At the general meeting of the French Society for the Encouragement of National Industry, held June 22nd, 1894, the distribution of the prizes and medals awarded by the Society took place.

The chair was taken by M. Tisseraud, president of the Society, who was supported by Colonel Pierre and M. Gustave Roy, vice-presidents, and Messrs. Collignon and Aimé Girard, secretaries.

The president opened the meeting with an address in which he called attention to the principal events of importance that had taken place since the last general meeting that had been devoted to the distribution of prizes.

The prizes were then awarded. We have already published in our number for July 25th, 1894, p. 314, a list of the awards in which electricians are interested. To-day, we intend to reproduce M. Mascart's report on the grand medal awarded to Lord Kelvin, and the particulars accompanying the electrical prizes offered for competition in 1895 and 1896.

The Grand Medal for Economic Arts.

Report made by M. Mascart as to Lord Kelvin's Qualifications for the Grand Medal Bearing the Effigy of Ampère.—The Committee of Economic Arts has the honour to propose to the Council to award the grand medal for Physical Arts, bearing the effigy of Ampère, for the year 1894, to Lord Kelvin (Sir William Thomson), president of the Royal Society of London.

Lord Kelvin's qualifications are so numerous and so well known that we need not enumerate them here; we will merely review a few facts in his glorious career.

Before he was seventeen years old, Mr. Thomson, then at the University of Cambridge, was reading the works of Fourier, and published his first article in answer to certain criticisms on the correctness of a formula relating to the development of functions in series. He takes pleasure in acknowledging that it was to Fourier that he owed his introduction to the scientific world, and when he was afterwards elected foreign associate of the Académie des Sciences, he did me the honour to say, in answer to my announcement of his election, that he was proud to belong to a society of which Fourier had been perpetual secretary.

Mr. Thomson followed the paths indicated by Fourier in a long series of researches relating to the propagation of heat, and showed, by many examples, that the methods of the great mathematician were applicable to the most varied problems of static or dynamic electricity.

Sadi Carnot's work on the motive power of fire drew his attention in 1849. He at once perceived the fruitfulness of this theme, and contributed largely to the foundation of that admirable chain of ideas that constitutes thermo-dynamics.

In 1854, an electrical engineer, a great authority on practical questions, laid before the British Association certain projects for electrical communication between England and the United States, explaining the technical conditions of the problem. Mr. Thomson expressed some doubt as to the correctness of the rules proposed; and a few weeks were sufficient to enable him to establish, thanks to Fourier's methods, the true theory of the transmission of signals by submarine cables, and he concludes his first pamphlet with this memorable sentence "We may be sure beforehand that the American telegraph will be a success"; in the same paper he gives the rules of construction and the numerical calculation of the time occupied of the transmission of signals. After some controversy in the scientific journals, the practical engineer who had commenced the discussion retired from the contest; feeling entire confidence in the scientific authority of the young Glasgow professor, he came to him to say that the society, founded with the object of establishing a transatlantic cable, would place itself under his direction, and to ask him to accept the post of consulting engineer.

Mr. Thomson accepted this proposal and at once devoted himself to the work. He suggested new modes of transmission, and at the same time devised all the apparatus necessary for the reception of the signals, and also the methods to be employed for testing the electrical condition of the submerged cable, and for finding out the nature and position of any faults that might occur.

The few dispatches sent by this first cable of 1856 were a brilliant demonstration of the correctness of the principles adopted. We may conceive that the breaking of this cable soon after, which has become a matter of history, did not discourage the capitalists that supported this gigantic enterprise. The final success came at last and the Government acted in accordance with popular feeling by conferring a title of nobility on the prime mover of this enterprise, who became Sir William Thomson.

Now that we see the ocean crossed in all directions by electric cables connecting the civilised nations of both worlds, we feel that we must render homage to the man of genius who united to a profound knowledge of mathematical sciences, the qualities of a clever physicist and the practical capabilities of an engineer.

We may add that the instruments devised at first for this new application of telegraphy, are in use at the present day, without any material alteration, after 37 years' experience.

It was Sir William Thomson's taste for navigation that drew his attention to questions relating to this branch of science.

The development of iron vessels entailed great difficulties in the use of the ordinary compasses, and all methods of correction failed. To the surprise of all interested in the question, Sir William Thomson showed that the rules adopted in constructing compasses must be entirely changed, and that the heavy needles magnetised to the utmost degree must be replaced by very light needles very slightly magnetised, so that as far as possible an infinitely small magnet may be realised, in which case the action of the soft iron of the vessels may be compensated by masses of iron of moderate dimensions. The Thomson compasses are now adopted for war ships and trading vessels all over the world. The approach to land becomes dangerous when the landmarks of the coast are hidden by fog. The Thomson sounding apparatus enables the captain to make a rapid series of soundings when going at full speed, and thus to correct his course by the comparison of his observations with the charts.

Before quitting this subject I will also call attention to the apparatus for tracing the curve of future tides for any part of the globe by means of a few data obtained previously, from which may be deduced the coefficients and the phases of different periods.

Thus his efforts towards the perfecting of the modes of communication between different nations, and towards greater safety in navigation, place the name of Sir William Thomson on the list of the benefactors of humanity.

I am obliged to pass over in silence a number of more abstract papers on the mechanics of the globe, the dissipation of energy in the system of the world, the conservation of solar heat, the relations that exist between the general properties of bodies, their molecular construction, the possible structure of the medium through which light is propagated, &c., to which must be added the masterly work published jointly with Mr. Tait under the title of "Treatise on Natural Philosophy." Sir William Thomson has grappled with all the great problems, but it is in questions of electricity and magnetism that his influence has been most manifest.

He has been the educator of the age. He has renewed theories, transformed our stock of scientific facts, opened up paths hitherto unforeseen, brought about the adoption of a logical system of units of measurement, and contributed immeasurably to the progress of electrical industry. At the time of the construction of the first submarine cables, it might have been said that the science of electricity belonged rather to the workshop than the class-room. A veritable revolution has been slowly accomplished; if the generations that follow us enjoy all the profit of it they know less about its origin.

A few years ago Sir William Thomson was elevated to the nobility under the title of Lord Kelvin of Largs. Availing himself of the privilege of choosing his new title, he took the name of the stream (Kelvin) that flows by the Glasgow University, where he has been a professor since he was 22 years old, and that of the little town (Largs) at the mouth of the Clyde, where he resides in summer. With some regret at the disappearance of the illustrious name of Sir William Thomson, the scientific world received the news of the distinction conferred upon him with unanimous approval.

The medal that we offer Lord Kelvin can add nothing to his fame. We hope, however, that the memory of Ampère is worthy to remind him of the esteem in which he is held, and that he will, under this form appreciate a testimony of our profound admiration.

Prizes to be Awarded in 1895 and 1896.

Prize of 2,000 *Francs for an Industrial Preparation of Ozone and for its Applications.*—Schönbein has proved the existence of a modification of oxygen to which he has given the name of ozone.

This modification is effected when oxygen or air is electrified; when by certain special processes the oxygen is liberated from the substances containing it; when phosphorus, essences, and certain combustible bodies are oxidised cold; and lastly, when the air is agitated by storms or modified by the action of living vegetation. Ozone possesses, as an oxidising agent, an activity beyond comparison with that of chlorine. It oxidises silver without heat; it destroys instantaneously a number of organic substances; it discolours colouring matter; it burns up effluvia, &c. It would have all the advantages of chlorine without, perhaps, its drawbacks. If an industrial process could be suggested that would enable ozone to be produced economically and to be preserved or utilised without difficulty, it would be a great advantage; for, after it has acted upon organic matter, for instance, ozone leaves behind only inert substances, water, and carbonic acid. Chlorine gives off, as we know, hydrochloric acid which must be got rid of; moreover, it takes the place of hydrogen in many cases and thus gives rise to complications

which must be taken into account, and which do not occur with ozone.

The Society is therefore disposed to encourage any effort tending to the production of ozone with economy and facility, and showing methods by which this remarkable substance can be so obtained and preserved as to be available for industrial purposes.

The prize is offered for a complete solution of the problem, but the society reserves to itself the right of encouraging any serious attempt, either at its preparation or application. The prize will be awarded, if competed for, in 1895.

Prize of 2,000 *francs for an industrial apparatus, or process, enabling the insulation of the various parts of an electrical installation at work to be rapidly measured or estimated.*—Different forms of instruments have long been employed in electrical industries for determining the variations of pressure at the sources of the generators, the amount of the current, and, consequently, the output or watts produced. The consumption or efficiency can be estimated by meters and by the work effected. There is another element which is of great importance, both as regards economy and safety; this is the insulation of the conductors, the apparatus and the masses of metal employed in the installation.

The instruments used in telegraphy, or in researches where strict accuracy is required for measuring insulation resistances would be too cumbersome, too delicate, or too slow. The indicators to be met with in the most completely fitted central stations only show a serious defect, and often when it is too late to remedy it.

A new industrial apparatus, or process, enabling us to measure, or to estimate correctly and quickly, the degree of insulation of the different parts of an electric installation in activity (machines, mains, transformers, and various working parts), and to observe its variations would supply a real want. It would largely contribute to the development and the increased safety of electrical industries, as it would supply them with the means of avoiding useless losses which lessen the efficiency and of removing a source of danger which is serious in installations working with high pressure currents, especially with the alternating currents which are now being extensively employed.

The society offers a prize of 2,000 francs, to be awarded in 1895, for the solution of this problem, which is of special importance to those interested in electric lighting, or in the transport of energy by electricity.

Prize of 3,000 *francs for the discovery of a substance capable of taking the place of gutta-percha in at least one of its principal uses, or for a system of operations that would help to develop the production of and facilitate the preparation of gutta-percha.*—Gutta-percha, which was only introduced into Europe in 1847, is the milky sap of a tree which only reaches perfection in the equatorial zone, at a certain altitude, and is found chiefly in the Malay Peninsula, and the islands of Sumatra and Borneo. Its use spread rapidly; it has been used for the insulation of electric wires and for many other purposes. It is absolutely indispensable for the construction of submarine telegraph lines. Now the production of this useful material, which is limited by the conditions to which the growth of the trees from which it is extracted is subjected, has not progressed in proportion to the development of its applications. The extraction of the sap has been performed by the natives without forethought, and the trees are gradually disappearing. Gutta-percha of the quality procured at first, which is the only quality suited to its principal applications, cannot now be procured. Notwithstanding a considerable rise in price we can only obtain from the places where it is produced, and commerce can only supply mixtures of gums of inferior quality having the same appearance, but not suited to the same purposes as gutta-percha.

The submarine cable industry suffers most from this want of good gutta-percha, and it is feared that it may be seriously compromised.

Engineers and scientists have been officially charged to study on the spot the conditions of production and the means of developing it, and to endeavour to cultivate the India-rubber tree in a French colony. They have arrived at results interesting as regards the future; but one cannot expect an immediate solution from these researches which the climate, the distance, and the organisation of the countries where these trees are cultivated render very delicate, very difficult, and very arduous. Inventors have also tried to substitute various substances for gutta-percha, but their experiments have only given uncertain results, or have not been sufficiently prolonged. The society foresaw this unfortunate state of affairs several years ago. In the hope of providing for the future, a prize of 3,000 francs was offered in order to encourage the study of this problem, but it has not yet been able to be awarded.

This prize is still kept on the programme, but the conditions of competition are less restricted. Not only do they admit constructors or inventors who shall propose a substance capable of being substituted for gutta-percha in one at least of its principal applications, and who can establish its value by a prolonged trial, but also scientists and explorers who, by a well-conducted system of operations, shall succeed in extending the production of gutta-percha or in ameliorating and perfecting its preparation.

This prize will be awarded, if any successful competitor presents himself, in 1895.

Prize of 2,000 *francs for an electric incandescence lamp having an intensity of* 1 *candle, and working at* $\frac{1}{10}$*th of an ampère, under a difference of potential of* 100 *volts.*—The incandescence lamps now in use have a luminous intensity of 8, 10, 12, 16 or 20 candles. These intensities, which answer very well for the lighting of shops, theatres, cafés, and certain rooms, are too powerful for small spaces, and even for large rooms where a soft light, not trying to the eyes, is required. We may, it is true, reduce the intensity of the ordinary lamps by using ground glass, or by introducing resistances into their circuits. But the expense for a given intensity is thereby increased; ground glass globes get dirty very quickly, and rheostats complicate the installation.

Electric lamps of very low intensity, producing in rooms very much the effect of stearine candles would be less trying to the eyes and would be better suited to decorative purposes than the more powerful lights. These lamps could be also used as night lights, and would be also well suited to passages and private entrances. At the maximum price charged by the Parisian stations (1·5 franc the kilowatt hour, each lamp of one decimal candle, expending ·05 of an ampère under 100 volts, would only cost ·75 of a centime per hour, *i.e.*, about one-fifth the cost of an "Etoile" candle. The manufacture of lamps with high voltage and low intensity would thus constitute a decided advance in lighting by electricity.

The prize will be awarded if a successful competitor presents himself in 1896.

If the problem is not absolutely solved the society reserves the right of taking into consideration the results obtained in the direction indicated.—*L'Industrie Electrique.*

CORRESPONDENCE.

Refuse Destructors for Electric Lighting.

Referring to your kindly notice in your issue of June 22nd of my letter which appeared in your contemporary, and as you apparently recognise that my attempts to elucidate this much vexed and complex question are in the right direction, some further particulars of my scheme for the utilisation of town refuse for steam generation for electric lighting might be of interest, at the same time correcting your confusion of the data given of the sifted breeze from that of the unsifted ash bin refuse.

Your remarks apply chiefly to the sifted breeze from the Paddington refuse, but it is the unsifted refuse that has to be disposed of. This I stated to have a minimum average evaporative value of 1 lb. of water to 1 lb. of refuse, it varying widely.

Ordinary boiler furnaces are totally unfit to burn this refuse, a feeding inlet and cleaning outlet being absolutely necessary, as the 25 per cent. to 30 per cent. ash and clinkers which arise from the unsifted refuse have to be mechanically removed in order to keep the furnaces in such a condition as to burn with the forced draught ten tons every twenty-four hours—so that a destructor form of furnace is essential. Your conjecture as to moisture is correct, from 10 to 20 per cent. is found in the ordinary refuse, and the gases emitted have contained 22 per cent. of nitrogen; and you rightly suggest that a high heat must be provided to destroy this, and which cannot be done in a water-lined furnace, hence a combination of water-tube or cylindrical boiler placed immediately over the destructor furnaces of fire brick, a perforated arch between them, becoming incandescent, acting as a relay of heat when new fuel is introduced, so that the moisture and obnoxious gases are partially burnt up and the remaining gases passing into the combustion chamber of the supplementary or ordinary boiler furnaces, and there burned and totally destroyed, is my system to attain this result.

To make this refuse take up the stand by losses, the refuse furnaces will continually be at work, but the boilers above them need not be, except one only. The waste gases—after keeping the idle boilers hot and at the working pressure—passing into the combustion chamber of the single (or more if necessary) boiler for the day load with the coal fires for cremating and for raising the steam pressure above that which the refuse alone will give.

You will therefore see that—allowing for moisture and non-combustible material—60 per cent. is the net available, under the best conditions; and this without any admixture of sludge, and allowing for radiation and loss in storage, will give an effective 27 electrical horse-power per hour per cell, allowing 20 lbs. steam per I.H.P.; the cremating fires yielding a further evaporation at the ordinary rates. In applying this plant I have not forgotten any excess of steam over the day load, this I propose to utilise by condensing or distilling the feed water for the night or heavy load, at same time sustaining this feed water at about 212° Fah.

My experience has shown me that the following considerations must be fulfilled:—

1. Facilities for feeding and cleaning the refuse furnaces.
2. Cremating and destroying the obnoxious gases and fumes.
3. Raising the steam to an economical working pressure.

4. Prevention of radiation and loss of heat—by placing the boilers close to the furnaces.

5. Storage of heat for any immediate and heavy demand, which my scheme will I submit, Sir, fulfil.

Some local authorities have been advised that the whole of the steam required to generate electricity for their areas can be obtained from refuse without any expenditure for other fuel, but from my experience I fail to see how this is possible, particularly, as I understand, the boilers and refuse furnaces are proposed to be in two separate batteries and not self-contained. Some engineers also have suggested that the end does not warrant the means; but, in my humble opinion, no doubt exists but that it can be made of great value, and certainly worth the laying down of a plant for its utilisation, apart from the barging saved.

I am of opinion also that the supplementary heat for cremating may be more advantageously obtained from producer gas or oil than with coal or coke, and the details of my scheme I might much more amplify, but I fear trespassing further on your valuable space.

T. W. Baker.

Blackening of Walls by Conductors.

We see among the "Notes" in your last issue what purports to be an explanation of the blackening of walls, &c., by wires carrying electric currents. It is stated that this blackening occurs only when the current is continuous, and not if it is alternating. This is certainly incorrect, as we have two marked cases of blackening, one of a ceiling and the other a wall, caused by a double flexible cord carrying an alternating current. The wire is 35/40 and the current ½ ampère. Hot water pipes and incandescent lamps can blacken walls and ceilings, and the cause is, in their case, the current of hot air rising from them. Is not the same simple explanation sufficient in the case of the wires carrying current?

The Electrical Accessories Company, Limited.
C. J. Schwind, *Secretary.*

September 3rd, 1894.

[It is perhaps scarcely necessary to say that the explanation offered was not our own, but was specifically stated to be that of Mr. Nellis, as it appeared in the New York *Electrical Review*.—Eds. Elec. Rev.]

Electric Lighting Contracts and Professional Advice.

I have followed with interest the correspondence on the above subject, and there appears to me to be a general consensus of opinion that "something ought to be done." The question is—what?

"Consulting Engineer" (Electrical Review, August 3rd, p. 139) suggests "that it is for the Institute of Civil Engineers, possessing, as they do, a charter to introduce some system whereby only duly qualified engineers should be recognized as such, and to issue some regulations or to confer some form of diploma or distinctive title upon those men who elect to follow the purely professional side of engineering."

As regards the first part of this proposal, while it would doubtless meet with cordial approval from the men who have qualified in the usual manner, it could not fail to be opposed tooth and nail by a large class whom I may term "financial engineers," and which embraces all sorts and conditions, from the plumber's salesman to the railway promoter, a class of able and respectable men, but scarcely qualified to claim professional status.

Again, unless it is proposed to discriminate between civil and electrical consulting engineers (a by no means easy matter in many cases), the second part of this suggestion is open to the objection that the Institute of Civil Engineers can scarcely be expected to burden itself with the troubles and requirements of purely electrical consultants. The Institution of Electrical Engineers being in the same position with regard to those who are members of the civil or mechanical denominations only, disqualifies the plan put forward by "Professional" (Electrical Review, August 7th, p. 204) that "members should be of two classes, viz., professional members and ordinary members, the extra qualification being a fixed number of years' professional practice," &c.

It should further be considered that each of the above societies is established for the advancement of its particular science generally, and should not be expected to give particular attention to any special class or section of its members.

There remains, then, with all due respect to certain correspondents of your doubtless highly esteemed contemporary, *Lightning*, your own suggested plan for the formation of "a strictly professional institution or society to which only purely professional gentlemen could belong." This appears to me to be the only satisfactory course, and the "*mere details*" regarding constitution and scope only remain to be settled. I would submit that the readiest means of arriving at these would be to convene an informal meeting of all those interested, and to elect a provisional committee of, say, six or eight (remembering that the work done by a committee is inversely proportional to the number of its members), and commission them to bring forward a definite plan for consideration at a second general meeting.

It will, of course, be necessary for someone to take the initiative in the matter of fixing the date, venue, &c., for the preliminary meeting, and I feel sure that my brother professional men will agree with me in the opinion that better hands could scarcely be found in which to place our interests than those of the editors of the Electrical Review.

C. Ashmore Baker.

September 4th, 1894.

[While sensible of the honour which our correspondent would thrust upon us, we cannot but feel that the initiation of such a scheme could be better undertaken by others. While we are interested in all matters affecting the practice of engineering, it would be, perhaps, travelling beyond our editorial functions to endeavour to give effect to a scheme which, however, we have at all times strenuously advocated.—Eds. Elec. Rev.]

The Pathology and Treatment of Electric Accidents.

The interesting article published in your last issue under the above heading induces one to suggest that the Council of the Institution of Electrical Engineers should be asked to prepare instructions detailing the best method of treatment for electric shocks.

The instructions could be printed on a card of convenient size for hanging or pasting up, should be illustrated with diagrams, and state concisely in simple language, and in the clearest possible manner, the best steps to restore consciousness and induce respiration.

The publications of the Royal Humane Society would serve as useful models.

Promptness of action is most requisite in cases of electric shock, and managers and those in authority may not be on the spot at the time an accident occurs, nor are doctors quickly available; but any workman of ordinary intelligence, with the above instructions, could take the necessary preliminary steps for restoring consciousness, pending the arrival of skilled assistance.

One such card could be fixed near any main switchboard, and another in the testing-room, and would, I feel sure, be welcomed by many central station engineers and factory managers.

H. W. Kolle.

Alternating Current Distribution.

In reply to Mr. Faber's letter in your last issue, I would like to inform him that poles *are* formed on a closed magnetic circuit if the primary and secondary coils are not superposed. That when such a closed circuit is divided through these poles and left free to move, they *do* repel each other. That strong currents in both coils are first what is required. That converters do not burn up as readily as he appears to think when the secondary coil is short-circuited. That when the conditions require it the short circuit can be made through a resistance.

With regard to the other points not being in accord with ordinary converter practice, he should remember that my controller switch plays an unique part in the circuit, being first a converter, secondly a potential raiser, and thirdly, when the primary circuit is broken, simply a pair of electro-

magnets, both coils being excited from the same source. I do not, therefore, expect that he will find ready-made formula to suit the case. I may further inform him that converters which I designed and made with my own hands before any of the present most excellent formulæ were thought out, are still working, and can give points and a beating to many modern types both for economy and insulation. It is not necessary that an inventor should follow accepted rules as long as he thoroughly understands natural laws and obeys them. Surely the man who built the first iron ship knew it would float; yet the vast majority were certain it would sink because it had not been publicly demonstrated.

In conclusion, I can assure you, Sir, that I thoroughly appreciate the value and necessity of public trials before vast sums of money are spent on inventions, but I believe that letters such as Mr. Faber's tend to prevent inventors receiving the support necessary for such demonstrations, and stop industrial developments. Premature publication is much more often made from necessity than choice by inventors.

W. Lowrie.

P.S.—I hope Mr. Faber's law of titles does not apply to man as well as inventions. If it does, the high places in this world must be unworthily filled.

The Advantages of Alternating Currents.

The sharply-worded criticisms in your current and previous issues of the paper by Prof. S. P. Thompson is surely unnecessary. The writer of your article selects a single phrase in the paper, and on that bases condemnations of alternating currents, laudations of submarine cable men, and explanations of elementary alternate current theory, which latter "any first year's student" is supposed to be familiar with. The reason for introducing "first year" lessons in a leading technical paper is not obvious; and the assumption that a professor who teaches first, second, third to *n* year's students is not acquainted with so elementary a part of his subject, hardly warranted.

Prof. Thompson says there is less *trouble from leaks* from alternate than from continuous current circuits, and specifies distinctly to what troubles he refers. The question of the breaking down of the insulation of a conductor by strains in the dielectric, to which, and that alone, your article refers, is not entered on at all.

Ernest F. J. Hewlett.

September 3rd, 1894.

[We do not altogether admit that our criticism was sharply worded. The one point raised by us was a fair and reasonable one, and we see no reason to modify this view. It did not refer to the breaking down of the dielectric, but of a *leak* in the dielectric. Our well-meaning correspondent may rest assured that no man is better able to defend his own cause than Prof. Silvanus Thompson. Still it may please him to know that we have the keenest appreciation of the value of Prof. Thompson's paper, indeed, it was this which led us to remark a fortnight ago that "we are gratified to find in Prof. Thompson an advocate not only of alternating current working generally, but particularly polyphase methods. His clearly expressed and favourable views entirely coincide with those we have so often expounded on the same subject.—Eds. Elec. Rev.]

Erratum.—In Mr. A. W. Bennett's letter on "Portable Batteries" last week a printer's error occurred in line 4. Instead of "of course the *loss* of time," read "the *test* of time."

The Hardships of Cable Men.—Mr. Herbert Laws Webb has contributed to the September number of *Scribner's Magazine* a most interesting story, which he entitles "Electrician-in-Charge." The story deals with an awkward experience of a young electrician who is left in charge of a cable hut in a most out-of-the-way part of South America. Cable men and electricians cannot fail to be interested in Mr. Webb's able production.

NOTES.

Obituary.—We regret to have to record that Mr. Charles Wood, late chief engineer of the mechanical engineering department of the Silvertown Works, died on Thursday last when only 55. He had done 23 years' useful work for the Silvertown Company. Charles Wood was a native of Glasgow, and served his apprenticeship with the Canal Basin Foundry Company—where his father had also previously been—and he continued in their employ till the year 1871 when he was offered the above-mentioned appointment at Silvertown. The factory of Messrs. S. W. Silver & Co., dates back as far as 1840, indeed, its able works manager (Mr. John Bailey) has been there since about 1855. In 1863 the firm was converted into a limited liability company under the title of the India-Rubber, Gutta-Percha, and Telegraph Works Company, and in 1866 Mr. Matthew Gray came from Scotland to take up the general managership, since which period an extra impetus has, undoubtedly, been thrown into the concern. We should imagine that Mr. Gray has more than once had occasion to congratulate himself on the possession of so able and energetic a mechanical engineer as Mr. Wood. Charles Wood was admired and beloved by all with whom he came into contact, both as a man and as an industrious engineer of much ability, ready in a quiet way to take an unlimited amount of trouble over anything that came along. Prior to his life at Silvertown, he enjoyed the esteem of the late Mr. John Turnbull, one of the most able engineers of the City of Glasgow. Mr. Wood will be sorely missed at Silvertown, and exceedingly hard to replace. In his department all the company's cable machinery—for the factory as well as for aboardship—was constructed, in addition to electric lighting apparatus and other general machinery, besides which, all repairs and alterations were here effected. On Monday last a number of his fellow workers and friends paid their last tribute of regard and affection at his grave's side.

Science in Australia.—We hear that the Australian Association for the Advancement of Science holds its annual meeting at Brisbane on January 11th, 1895, and following days.

Climbing the Heights of Investigation.—The *Street Railway Review* tells the story of the adventures of an ambitious lad whose researches were among "the 'igher flights," and came to a sad ending:—"Little Dannie Ferguson is a Brooklyn youth of nine summers. He never had the advantages of a correspondence school of electricity, nor as yet is he an E.E. But he nearly became a D.C., which means a dead corpse, on account of original investigations in electricity. This young martyr to science, in company with some other boys, thought it would be a fine thing to climb a centre pole of the Atlantic Avenue Railway. Dannie was first at the top, and grasped boldly at the wire. The connection was only fair, but it took two doctors two hours to bring Dannie back to a realisation of circumjacent material objects, and the arms of his tearful parents."

Electrical Muscle Making.—Some recent scientific researches, which, a New York contemporary says can doubtless be trusted, show that the weight of muscles of animals was increased 40 per cent. by a proper periodic application of an electric current, the growth being a true development of the muscle. According to this it will now be possible to increase to order the size of any desired muscle without tiresome gymnastic exercises, by simply lying in a soft chair and having the current applied. This, we suggest, might be done at night by an automatic apparatus, thus saving time. Persons who are improperly developed may now be balanced or "trued up;" muscles shrunken by age may now be made plump again. Calves, which nature or want of exercise has failed to develop sufficiently, will now no longer be a drawback to wearing the knee breeches, kilt, or short bloomers of the female bicyclist. The question naturally suggests itself, What will happen if this process of developing muscles electrically is continued still longer? If some way is then found to develop the bones, the manufacture of giants by electrical means will be an easy matter.

Rome-Naples Telephone Line.—The *Financial Times* states that telephonic communication between Rome and Naples will be opened in November.

Electro-Harmonic Society.—The dates of concerts for the 1894-1895 session have been fixed as follows:—September 28th and October 26th, smoking concerts; November 30th, ladies' night; January 25th and March 29th, 1895, smoking concerts; February 22nd, ladies' night.

Personal.—Our note of last week with reference to the selection by the Council of Mr. Charles Bright, C.E., for fellowship of the Royal Society of Edinburgh was based on some remarks thereon in the *World*, which we now reproduce in full, including, as they do, an interesting and suitable reference to Sir Charles Bright's work so early in life. These remarks were originally to be found under the *World's* article "What the world says," and read as follows:—

There is something of historic interest in the nomination by Lord Kelvin of Mr. Charles Bright, C.E., to fellowship of the Royal Society of Edinburgh, for which the latter is now a selected candidate. Lord Kelvin and the late Sir Charles Bright were old shipmates, as the electrician and the engineer respectively of the old Atlantic cable, for the successful laying of which Sir Charles received knighthood at the unprecedentedly early age of 26. His eldest son, Lord Kelvin's nominee at Edinburgh, seems to be gradually coming to the front on the same lines as his distinguished father, one of whose well-remembered feats was laying down, when only 18 years old, the telegraph lines under the streets of Manchester in a single night, to avoid disturbance to the traffic, thus for the first time putting Liverpool and Manchester into telegraphic communication with London. Mr. Charles Bright's recently published volume on "Subterranean Telegraph Cables" marks him as a close scientific observer with keen practical instincts, and embraces a wider range than its title implies. There have been books before giving the history of submarine cable laying expeditions, but never one furnishing the precise course of events from start to finish, and showing with minute detail how the inevitable difficulties in a treacherous climate, that of the West Coast of Africa, where Mr. Bright was in charge of the enterprise on behalf of the Silvertown Company, are grappled with and overcome. But in these days, when the electric lighting of our houses and streets is spreading in every direction, and millions of public money are being invested in the sources of supply, it is of vital interest to every one concerned, be he shareholder or be he consumer, that the best, safest, and most enduring means should be adopted. On this head Mr. Charles Bright imparts a vast amount of information based on personal knowledge and experience, and presented in a form which the veriest outsider can read with profit, and understand without effort.

An Adjustable Electric Lampholder.—The illustration, for which we are indebted to the *Scientific American*, shows a simple and inexpensive bracket device, by means of which an electric lamp may be conveniently placed where desired, by simply being moved into position by the hand. It is made by the Faries Manufacturing Company, of Decatur, Ill. The smaller figure shows the simplest form of the device,

another style having two arms and a bracket, with eyes to slip over a ¾-inch iron pipe, the curved section working in the outer end of a horizontally swinging arm. The combined length of all these sections is 5 feet, so that the lamp can be placed in any part of the space within a circle of 10 feet. There are no screws to be manipulated in making any of the adjustments, except when moving the bracket up or down the post.

British Exhibitors and the Chicago Exhibition.—Complaints continue to be made regarding the administration of affairs at Chicago. Last week we recorded the protest of a large body of the British exhibitors regarding the mismanagement, and the neglect of the officials. A communication has since appeared in the *Times* complaining that, although the exhibition was closed a good ten months ago, the awards declared, after six months' delay, in April last, have not yet been received. Enquiries addressed to the British Commission fail to elicit any satisfactory reply, hence it would appear they are as much in the dark as the exhibitors themselves. It is even stated from a certain quarter that the medals awarded are not yet designed. If the management arrangements carried out at Chicago Exhibition are considered by a certain esteemed New York contemporary "good and original," they are welcome to lay full claim to all the credit that may be due to them.

Lighting of Patent Office Library.—Considering the very fine points involved by patent law, and the uncertainty of patent definition, it is strange that the library of specifications and reference, and the library of technical works in connection with it, should be the most ill-lighted public building in London. A few very low-type gas burners in almost opaque globes are doing their best to ruin the books and strain the eyes. It is obvious that the dimness is due to neglect rather than to poverty, for the funds which maintain the library are provided by the Government and take a distinct place among the estimates. The electric light mains are almost at the door, and the building seems particularly well adapted to glow lamps. Not long ago we called attention to the comparatively small attendance of readers at this valuable library; as the longer evenings are approaching it seems a pity that those who do avail themselves should be given so poor a light, and we hope that the authorities will make a judicious selection from the countless specifications with regard to "Improvements in public lighting" which are piled upon their shelves.

A Long Lived Cable Fault.—In the year 1866 Reuter's Telegraph Company laid a cable containing four conductors between Lowestoft and Norderney, in Germany. The cable came into the hands of the Government at the transfer of the telegraphs to the State in 1870, and it was then handed over to the Submarine Telegraph Company for their use and for their maintenance. On the expiry of this company's license in 1889, the cable again came into Government keeping. In the meantime, however, a fault had appeared, and this was inherited by the Postal Telegraph Department, among other legacies. The principal part of the cable, buried securely in the sands at the bottom of the North Sea, has been working ever since it was laid. The faulty conductor was that connecting up a circuit working between London and Hamburg, and known officially as No. 70. The other three conductors in the cable have worked perfectly, but No. 70 has given trouble for a long time past; indeed, the fault has existed at least from 10 to 12 years. However, by exercising great care, working with copper currents both ways, and by resorting to single-current Morse working instead of Hughes, a fair amount of work has been got out of the circuit. Zinc currents always rapidly developed the fault to an apparent total disconnection. Recently the working has become more troublesome, and the Postal Telegraph authorities decided to cut out the fault. It was localised about 50 miles from the German end, but only about four miles from the shore. Last week the Post Office cable ship *Monarch*, after much trouble in grappling the cable, pulled it out from its sandy bed, cut out the fault, and spliced in a new piece. The fault proved to be due to a slight defect in the gutta-percha dielectric. This defect, probably an air hole, was evidently discovered during manufacture, for the surface bears evidence of having been tooled up at this point. The weak spot was not quite sealed up, and the working currents year after year have gradually opened out the fault. In appearance it is similar to all cable faults caused through the breaking down of the dielectric. The great peculiarity about the matter is the long period that has elapsed since the fault first gave evidence of its existence. It also illustrates in a remarkable degree what can at times be done in such cases by careful nursing.

Electric Light at Mysore.—An Indian contemporary states that preparations are being made to light the Maharajah's Banquetting Hall at Mysore by electricity.

A Balloon Struck by Lightning.—A remarkable balloon accident occurred on the 5th at Aldershot. The Duchess of Connaught had consented to christen a new balloon—the largest military balloon yet made—which had been constructed at the New Ballooning School at Aldershot. Another new balloon had been got in readiness to make a trial ascent, and it went up as a captive without any one being in the basket. No sooner had it got the length of the cable than it was struck on the top by a vivid flash of lightning, which at once set it on fire, whilst the electric discharge, running down the wire, struck four men who were holding it, seriously injuring them.

BUSINESS NOTICES, &c.

Dundee and Electric Lighting.—The minutes of Dundee Gas Commission just issued contain the detailed report by Messrs. Urquhart and Small on the addition proposed by Mr. W. H. Brownlee, the electrical engineer, to the plant at the central station in Dudhope Crescent Road. Therein Messrs. Urquhart and Small point out that, as their engineer had reported, the amount of current already applied for was 3,481·1 ampères; that from experience the station might be called on to supply 80 per cent. of this demand at one and the same time, so that the plant should be able to supply 2,785 ampères without fail. The total available output of current from the present plant could only be taken at 3,000 ampères, and this only on the assumption that all the larger machines are in proper working order. Should one of these larger machines break down or be unable to be used owing to repairs, &c., then the available amount of current would be reduced to 2,300 ampères, which was 485 ampères, or nearly 18 per cent., below the total amount which experience had shown might be called for. It was therefore evident that an addition to the present plant was imperative. The additional plant which they recommended consisted of a steam dynamo, placed to the south of the present line of machines, the engine to be capable of giving 200 indicated horse-power, so that it would be suitable for driving a dynamo which would generate 560 ampères. The above addition to the engine power would necessitate the addition of a fourth boiler. With the proposed additional engine the quantity of steam to be condensed would amount to 13,400 lbs. It would therefore be necessary to enlarge the area of the condenser by the addition of at least sixty new pipes. The extension of the existing plant would cost the sum of £2,500. The committee recommend that the proposed new boiler be dispensed with, and that only one engine be procured.

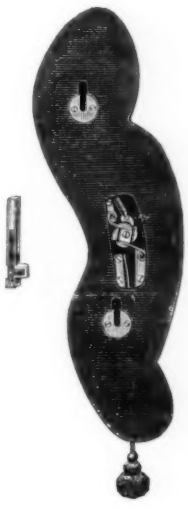
Ship Lighting.—On Saturday, September 1st, at high water, the s. *Duke of York* was launched from the Thames Electric and Steam Launch Works, Eel Pie Island, Twickenham. The principal dimensions of the vessel are, viz.:—Length from stem to taffrail, 80 feet; beam, 14 feet; depth moulded, 7 feet; draught aft, 3 feet 6 inches. The main saloon is artistically decorated, and down the centre of the skylight are ornamental lacquered brass electroliers fitted with incandescent lamps. The electric light is fitted to all parts of the vessel, the current being obtained from a 50-volt circuit, and incandescent lamps are arranged in the port, starboard, and masthead lights. This vessel has been designed to give a speed of nine knots an hour, by Mr. W. S. Sargeant, general manager of the company for passenger service between the new lock at Richmond and Hampton Court Palace. The *Duke of York* immediately she was launched was towed round Eel Pie Island, with 176 people on board, by one of the company's electric launches, working on a 120-volt circuit, and the motor running at 600 revolutions absorbed 4,560 watts, being a little over 5 brake horse-power. The company have a number of boats on the stocks, including two electric launches which will shortly be launched, one being for the Ormond Club and the other for India.

The Collier Audible Telephone Syndicate, Limited.—Under a winding-up order made against the Collier Audible Telephone Syndicate, Limited, last July, meetings of the creditors and shareholders were held last week before Mr. Winearls, Assistant Receiver. The syndicate was registered in April, 1891, to acquire and develop the inventions of Mr. A. T. Collier, for improved telephonic receivers and transmitters, and to carry on the business of a telephone and electrical manufacturing and supply company. The nominal capital was £9,000, and the promoters were the London and Colonial Finance Corporation, Limited. In 1892 the assets were sold to the Collier-Marr Telephone and Electrical Manufacturing Company, Limited, for £50,000, payable in cash and shares. The syndicate in that year, for the purpose of carrying out the sale to the company, went into voluntary liquidation, but eventually the compulsory winding-up order was made on the petition of a creditor. The appointment of a liquidator will be referred to the Registrar for decision.

New Swindon and Electric Lighting.—The question of obtaining a provisional order has been referred to the electric lighting committee.

Waltham's Combination Bracket Fittings.—The first illustration shows a long backed bracket (of registered design), which is supplied mounted on plush block, with a tassel for controlling a small switch which is concealed from view. The lights are very easily turned on or off by pulling the tassel, which

is connected with a strong silk cord. These switches, which are mounted on ebonite, as shown in the second illustration, can be fixed to any fancy block and the holding pins, which make a secure and rigid fixing by sliding into the slots shown above and below the switch, can be fastened to any fitting, thereby doing away with screws, which are unsightly. Another feature of interest



is the sliding two-side contact, which is shown at the bottom of the switch. The other contact plates, which are in direct connection with the wires of the fitting, are permanently fixed to the bracket itself. These are well insulated from it by mica, and make sure contact at the moment of sliding the bracket into its place; this entirely does away with all loose wires and all soldered joints. The backs of the switches are well insulated from the wall by an additional plate of ebonite through which the mains pass.

Aberdeen Electric Lighting Accounts.—The electric light accounts, which have been issued along with the other Corporation accounts, show a net loss for the period dealt with of £292 6s. 10d., the greater proportion of this sum, however, being interest on mortgage and other loans. To effect the installation and the erection of buildings and plant £20,000 was borrowed on mortgage, in addition to £1,020 of temporary loans. The buildings cost £3,719 12s. 6d.; machinery, £5,458 2s. 9d.; accumulators, £745 19s. 2d.; mains and systems, £8,150 11s. 7d.; electrical instruments, £1,074 5s. 8d.; meters, £599 11s. 9d.; general stores, £417 16s. 6d.; and general capital expenditure, £895 3s. 3d.—a total of £21,061 3s. 2d., or £41 3s. 2d. more than the amount of the loans. The working expenses for the eight months under review amounted to £289 9s. 6d., but the revenue came short of this by £52 5s. 3d. The sale of current realised £191 18s. 11d.; rental of meters, £14 12s. 4d.; and £30 13s. is debited to the town for the lighting of the streets. The total quantity of electricity generated was 9,833 units, of which 1,589 was used for public lighting, 6,581 by private consumers, and 261 in the works. This leaves 1,402 units unaccounted for.

Price Lists. — From Llewellin's Machine Company, Bristol, we have received lists of their various kinds of time checkers, watchmen's watches, ratchet and other wheels, &c. The lists are fully illustrated.

The Whitney Electrical Instrument Company, of Boston, U.S.A., have sent us one of their 1894 illustrated catalogues of voltmeters, ammeters, indicators, and electrical measuring instruments.

Messrs. C. Joyner & Co., of Birmingham, have also sent us lists illustrative and descriptive of their "concentric" adjustable pendants, "distribution" ceiling roses, and other specialities. The list is on enamelled paper, and the blocks illustrating the various fittings are good, and are also clearly printed. Detailed prices are stated.

Messrs. Alfred Herbert, Limited, have sent us some very well got up lists of grinding, milling (horizontal and vertical) machines, cutter grinders, sensitive drills, lathes, the universal cutter grinder, and another list of special machinery for cycle manufacture.

Messrs. Ernest Scott & Mountain, Limited, have sent us a catalogue of electrical plant and machinery as manufactured at their works. The book is divided into sections as follows:—Description of the works and manufactures; Tyne dynamo machines; transmission of power by electricity; motive power plant; arc lamps; electrical accessories; electric light fittings; bells, telephones, &c.; domestic apparatus; engineering specialities and machinery. There are a great number of illustrations, some of them being full-page size. On the whole, the book is a very good production and has been very nicely got up.

Glasgow Electric Lighting.—Last week a joint meeting of the Lighting Committees had under consideration the cost of the electric lighting of streets. The Electric Lighting Committee represented that, as the cost of each lamp is £30 per annum, they could not continue to supply electricity at £20 per lamp per annum, which has been the price since the new illuminant was installed in the main streets of the city. It appears that the cost is very much more than was anticipated. The Electric Lighting Committee, being desirous of charging as reasonable a price as possible to the Watching and Lighting Committee, named £26 per lamp per annum as the sum they were willing to receive in future. The members had some difficulty in agreeing to the proposal, in view of the price originally fixed, and eventually they resolved to report the matter to the Watching and Lighting Committee.

The Gas Committee has agreed that the price of gas should remain at 2s. 6d. per 1,000 cubic feet, and that the price of electric light should be continued at 6d. per Board of Trade unit.

Railway Station Lighting.—Last Monday there was opened at Sheffield the Midland Railway Company's new Wicker goods station. On the Spital Hill side of the yard an engine house has been erected, in which are placed the engines, boilers, dynamos, &c., for working the hydraulic appliances, and the electric light. The electric light installation consists of three single cylinder horizontal engines, by Marshall, Sons & Co., two indicating 80 horse-power each, and one 30 horse-power, four 35-light arc dynamos, of the Thomson-Houston pattern, and one incandescent dynamo for 300 16-candle-power lamps by Mather & Platt. The incandescent lamps are for the offices, and in the Wicker warehouses and yard, and the engine shed, Cardigan and Grimesthorpe sidings, there will be upwards of 110 arc lamps, each of 2,000 candle-power. Mr. W. E. Langdon, the company's electrical engineer, is responsible for the electric light installation.

Braulik v. Sharpe and Kent.—Before Mr. Commissioner Kerr, the other day, the plaintiff, of 217, Upper Thames Street, claimed the sum of £2 2s. 6d. for electrical goods supplied to the defendants, Messrs. Sharpe & Kent. Mr. Kent, one of the defendants, said that the goods were bought on appro. The plaintiff's traveller said he admitted having taken the order on appro., but he said it was explained at the time that if the defendants wanted to return the goods in a fortnight or three weeks the plaintiff would be willing. But the defendants had kept the goods for 12 months. The defendant Kent said he bought the goods on appro., which meant that if they were not sold they were to be returned. Mr. Commissioner Kerr said he did not know the meaning of the words in the electrical trade. He adjourned the case until October 4th, for trial before a jury.

Electric Lighting at Leigh (Lancs.).—The directors of the Leigh Co-Operative Society, Limited, after much consideration, have decided to adopt electric lighting throughout their central premises, and are putting down a horizontal steam engine of 18 horse-power, and a large dynamo capable of supplying current to 240 lights, with wires and fittings complete. By doing this, it is said, they will effect a considerable reduction in their insurance policies in connection with the flour mills. Messrs. B. Verity & Sons (Manchester branch), who are very busy in all departments at present, have been instructed to carry out the necessary work.

Darlington and Electric Lighting.—Some members of the Gas Committee have had an interview with the Board of Trade with regard to the powers granted the Corporation in 1890 for lighting the borough with electricity. The Council have not taken any action in the matter as yet, but have been anxious to retain the powers, and representations to this effect were made to the Board of Trade. They were assured by Mr. Hopwood that the powers would not be withdrawn, and that as the Corporation desired to enlarge the area over which they could have power of supply, they would be granted all possible assistance by the Board of Trade in the matter.

Personal.—Viscount Templetown, who is a member of the Institution of Electrical Engineers, has been elected a director of the Portrush Electric Railway, in County Antrim, in succession to Lord Kelvin.

The Electric Light at Dover.—We understand that house wiring is being extensively carried on. Skilled workmen from London are now engaged in putting in the conductors in the offices of several local tradesmen. The work of building the electric light station is going on rapidly. The chimney, which is now a local landmark, is nearly 90 feet high, and has about 30 feet more to be added before the top stone is put on. The walls of the engine-house are now up and the roofs are being put on. The Dover Electricity Supply Company have announced that they hope to be in a position to supply both light and power to public and private consumers in the borough by the end of the present month.

Theatre Electric Lighting.—The New Grand Circus at Bolton will be lighted by electricity. The contractor for the work is Mr. Wm. Townson, the electric lighting being under the supervision of the Swan-Edison Company, Limited.

Coatbridge Theatre, which has lately been altered and improved, has also an electric lighting installation. Three electric arc lamps of 1,000 candle-power each have been fitted up over the entrances. At the box-office lobby is a 200 candle incandescent electric lamp, while on the dress and balcony landing a brass electrolier with three 32 candle-power lamps have also been placed.

Cooking by Electricity.—Messrs. Crompton & Co. are showing electrical heating and cooking at the Food and Cookery Exhibition, Manchester, and their demonstrations are creating great interest. Several dinners have been cooked, and chops and steaks are supplied daily to visitors. The new electric grill recently introduced, cooks to a nicety, at a small expenditure of current. Messrs. Crompton have been awarded a gold medal.

Electric Light at Portsmouth.—The electric light is well received in Portsmouth. The rate of progress will be shown by the following fortnightly record of lamps:—June 6th, 2,094; June 20th, 2,508; July 4th, 2,863; July 18th, 3,087; August 1st, 3,517; August 15th, 3,674; August 28th, 3,740. The Electric Lighting Committee and a local paper recommends the Council to see about laying down additional plant.

Electric Lighting of Chelmsford.—Doulton patent stoneware conduits are being used in connection with the lighting of Chelmsford. We understand that large quantities of these conduits are now being laid at Edinburgh and Sunderland, and it has been also adopted by two of the London electric supply companies. Although this invention is a comparatively recent one, the quantity now laid or on order amounts to upwards of 72 miles of "ways."

Electric Light in the West End.—The St. James's and Pall Mall Electric Lighting Company recently applied to the St. George's Hanover Square Vestry for permission to lay a main in New Bond Street. The vestry has refused its sanction on the ground that the company has no powers to lay mains in the parish. The surveyor considers there are already enough companies in the district.

Universal Electrical Directory (J. A. Berly's).—Messrs. H. Alabaster, Gatehouse & Co. have now in course of preparation the 1895 edition of this directory, which embraces all connected with the electrical trades throughout the Universe. It is indispensable to all having business transactions in the electrical world.

School Electric Lighting.—At to-day's meeting of the Wolverhampton School Board on Friday, the General Purposes Committee will recommend that the tender of Messrs. T. W. Scott and Co., electrical engineers, of Birmingham, amounting to £233 10s., be accepted for effecting an installation of the electric light at the Walsall Street new school.

Edinburgh Electric Lighting.—The inhabitants of George Street, Charlotte Square, St. Andrew Square, &c., have petitioned that these streets shall be lighted by electricity. The Town Council the other day discussed the matter, and by 14 votes to 12 rejected the recommendation of the committee which was that the light be extended to these streets.

Electric Light at Worcester.—There are stated to be a good many applications in hand for current; the applications already acceded to include several churches. The Watch Committee are recommending the Town Council to vote £1,000 as working capital, to pay the cost of such extensions as may be considered necessary.

Electric Lighting at Winchester.—A meeting was held last week, at which a number of ratepayers were present, for the purpose of discussing how best the views of the whole body of ratepayers could be ascertained regarding the rival schemes for lighting the city by gas or electricity. The meeting adjourned for a week.

Ilkley Electric Lighting.—Last week a Local Government inquiry was held regarding the Local Board's application for power to borrow £2,600 for improving and enlarging the gas works. Some opposition was made by a ratepayer who said that Ilkley wanted the electric light and was very likely to get it.

The "Unique" Switch.—Mr. A. P. Lundberg informs us that there is a large demand for these switches. The majority made remain in this country, but a large number are sent abroad. An order has lately been received from Austria for 1,000, and from Africa for 500, switches.

Peto & Radford.—This firm have in hand the following among other contracts:—Dynamo, accumulators, and 200 lights for Batchelar's Fireproof Warehouses, Croydon; dynamo and 100 lights at Messrs. Wilson's, Croydon; also wiring at Barkston Gardens, Wetherby Gardens, Birchin Lane, Great Russell Street, &c.

Dock Lighting.—The chairman of the East and West India Dock Company says that, after spending £12,000 upon a new electric light installation, it has resulted in a saving, during six months, of £1,000.

Wrexham and Electric Lighting.—The Board of Trade has agreed to defer the consideration of the question of the revocation of the provisional order of the Wrexham and District Electric Supply Company, Limited, for twelve months.

Lancaster and Electric Lighting.—The Town Council has appointed a sub-committee to consider the lighting of the streets by electricity.

Electric Lighting at Preston.—Dr. John Hopkinson has been appointed to consult with the Markets Committee regarding the lighting by electricity of the Town Hall and Public Hall.

Electric Lighting at Hampstead.—October 1st has been fixed as the date for the public installation of the electric light.

Auckland and Electric Lighting.—The City Council have the question of electric lighting before them.

Pontypool Electric Lighting.—The New Market was lighted by electricity for the first time on August 25th.

CONTRACTS OPEN AND CLOSED.

OPEN.

Barnsley.—September 8th. Tenders for the lighting of the outside of the Empire Palace of Varieties, Westgate, Barnsley, with three arc lamps and gas engine, &c., to work same, for the proprietors.

Belgium.—September 12th. Tenders are being invited until the 12th inst. by the Belgian State Railway authorities at La Bourse, Brussels, for the carrying out of an electric lighting installation at Guillémins Railway Station, Liege.

Cardiff.—September 12th. For the wiring of the Town Hall and Market Buildings for electric lighting purposes, including the supply and fixing of all cables, switchboards, casings, &c., &c., but not lamps and fittings. Further particulars from the Borough Engineer.

Edinburgh.—September 17th. The Corporation invite tenders for the following in connection with the electric lighting of the city: Contract No. 18, supply of arc lamp-posts. Drawings can be inspected, and all information supplied at the office of the consulting electrical engineer, 14, Old Queen Street, Westminster, S.W., or at the office of the resident electrical engineer, Dewar Place, Edinburgh.

London.—The County of London and Brush Provincial Electric Lighting Company, Limited, invite tenders for the supply and delivery of about 700 tons 2-inch and 2½-inch cast-iron spigot and socket pipes, the 2-inch in 6-feet lengths, weighing not less than 42 lbs., and the 2½-inch in 9-feet lengths, weighing not less than 84 lbs. per length. Full details obtainable from Mr. A. J. Lawson, engineer and manager.

London.—Tenders are being invited for the construction of a short line of railway on the outskirts of London, including the necessary materials. We do not know what district this railway is required for, neither have we been informed as to whether electricity is to be used, but full particulars can be obtained on application to Mr. R. F. Anderson, A.M.I.C.E., Ryde, I.O.W.

Portsmouth—September 22nd. Tenders are invited for the purchase of certain electrical plant at the Town Hall, Portsmouth. Full particulars can be obtained on application to the Town Clerk.

South Shields.—October 31st. The Corporation invite tenders for the supply and erection of electrical plant, including boilers, engines, pumps, alternators, mains, lamps, &c., &c. Full details will be found among our advertisements.

CLOSED.

Edinburgh.—The following tenders have been accepted by the Town Council Electric Lighting Committee:—S. Z. de Ferranti, Limited, steam alternators, switchboards and rectifiers; India-Rubber, Gutta-Percha and Telegraph Works Company, Limited, for insulated cables. The total amount of the two contracts is between £4,000 and £5,000.

Lancaster.—The Electricity Supply Committee have resolved to purchase 10 Crompton arc lamps for the electric lighting of the market.

Paddington.—The Public Baths are to be lighted by electricity, Messrs. Dawson, Hammond & Co.'s tender being accepted for the work. The Commissioners intend asking the Metropolitan Electric Supply Company for a reduction in the price per unit.

Portsmouth.—Tenders for the electric light installation at the Technical Institute, Landport, were received as follows:—Messrs. Haydon, £247 10s.; F. W. Walker, £198 10s.; Grossmith, £169; Bowerman Bros., £190; Southby, £185; Penning, £199. Mr. Grossmith's tender has been accepted.

Reading.—The following tenders were received for the erection of basement, &c., works at the central station, Vastern Road, for the Reading Electric Supply Company, Limited, that of Mr. E. Blackwell being accepted.

G. Wernham	£525	0	0
F. Talbot	467	3	11
Higgs & Sons	435	0	0
Bottrill & Son	423	0	0
T. H. Kingerlee	420	0	0
A. Jackman & Son	411	15	0
F. McCarthy	395	0	0
E. Blackwell, Reading	386	0	4
C. & G. Allen	366	0	0

Worcester.—Three tenders for the wiring of the generating station at Powick were received, and that of Messrs. Paterson and Cooper at £206 was accepted.

Worcester.—The tender of the National Telephone Company for connecting the generating station, the Guildhall, and the waterworks by telephone, at £31 10s. per annum, has been accepted.

CITY NOTES.

The Electric Construction Company.

What we may term the clean sheet of the company has just been issued. Considering the trying period through which the company has had to pass, criticism would perhaps be a little unfair. Manufacturing profits are perhaps higher than could be expected with a staff that must have been for some time disorganised. General charges are not very low, but can scarcely be considered excessive. The items in the report which inspires us least with confidence is the shares and debentures of other companies which stand at £147,872, and this feeling is not modified by a footnote which states that there is a contingent liability in respect of amounts uncalled on certain of these shares. It would be interesting to know in what companies these shares are held. It is interesting to note that the liabilities have been reduced during the year by £48,236. On the whole, however, we can fairly compliment the company on its year's work, and it will not be too much to expect that the next report will show much improvement.

The Electric Construction Company, Limited.

The balance-sheet and profit and loss account for the twelve months from July 1st, 1893 (the date on which the business was taken over from the corporation), to June 30th, 1894, shows that during the year shares and debentures of other companies have been sold at a profit of £15,764 10s. The profit and loss account shows a gross profit of £55,362 2s. 9d., and, after deducting all general charges, interest on debentures and borrowed capital, and cost of maintaining buildings, plant and patents, and a sum of £3,000 for depreciation, there remains £18,467 13s. 8d. The directors recommend that this balance be appropriated as follows:—

£	s.	d.	
12,500	0	0	in reducing the amount at debit of "shares and debentures of other companies account."
1,888	2	1	in writing off the reconstruction and preliminary expenses, and
1,819	6	0	in paying the dividend on the preference shares at the rate of 7 per cent. per annum for the year, leaving
2,260	5	7	to be carried forward to next account.
£18,467	13	8	

The working expenses compare favourably with those of the old company, and further economies will be carried out as opportunity offers. The liabilities of the company have been reduced during the year by £48,236 6s. The business has to some extent been interrupted by the reconstruction of the company and the reorganisation at Bushbury, and under the circumstances the results for the year may be considered satisfactory. The directors have confidence in the ability and loyalty of the staff, and with the excellent factories and capable artizans of the company, improved results to the shareholders may reasonably be expected. Several important electrical contracts have been carried out during the year. The working of the Liverpool Overhead Railway was handed over to that company to their entire satisfaction on January 1st last. The electrical tramway of the South Staffordshire Tramways Company continues to be worked by this company, and the cost of working for a period now exceeding 18 months demonstrates the great superiority and economy of electricity as compared with other modes of traction. Numerous orders for electric lighting, and other applications of electricity, are being executed.

Profit and Loss Account for Year Ended June 30th, 1894.

	£ s. d.	£ s. d.
To General Charges—		
Salaries of managing director, late works director, chief engineer, head office, and works staff	9,329 6 5	
Trustees for first and second mortgage debenture holders, fees, and expenses	228 9 0	
Directors' fees	1,500 0 0	
Travelling expenses	1,463 15 5	
Rent, rates, and taxes at head office and works	970 14 7	
Advertising	920 9 2	
Law charges	404 5 4	
Insurances...	105 0 3	
Postages and stationery	910 5 2	
General and office expenses, bank charges, stamp duties, and sundries	983 9 5	
Commissions and agency charges ...	237 16 3	
		17,053 11 0
„ Additions to plant and buildings and maintenance thereof, and patent fees	1,669 4 3	
„ Amount placed to depreciation account	3,000 0 0	
„ Interest on loans and debentures to June 30th, 1894—		4,669 4 3
On loans	4,739 9 10	
On debentures	10,432 4 0	
		15,171 13 10
		£36,894 9 1
To net profit carried to balance-sheet ...		18,467 13 8
		£55,362 2 9
By gross profit—	£ s. d.	£ s. d.
On manufacturing and contracting ...	25,754 10 5	
Rents, profit on maintenance contracts, premiums from pupils, and sundry profits	8,140 8 6	
Interests and dividends on debentures and shares of other companies ...	5,680 7 10	
Transfer and registration fees ...	22 6 0	
		39,597 12 9
By profit on realisation of shares and debentures of other companies ...		15,764 10 0
		£55,362 2 9

Capital and Liabilities.

Dr.	£ s. d.	£ s. d.
Capital authorised—		
150,000 Ordinary shares of £2 each	300,000 0 0	
50,000 Cumulative 7 per cent. preference shares of £2 each ...	100,000 0 0	
	£400,000 0 0	
Capital issued—		
120,000 Ordinary shares of £2 each, fully paid	240,000 0 0	
Of which 10,000 shares (issued for income bonds under scheme of reconstruction) held as security, since released	20,000 0 0	
	220,000 0 0	
12,995 Cumulative 7 per cent. preference shares of £2 each, fully paid	25,990 0 0	
		245,990 0 0
Debentures issued—		
1,254 First mortgage 6 per cent. debenture bonds of £100 each (authorised issue, £150,000) ...	125,400 0 0	
246 *ditto, issued and deposited as security*, 24,600		
6 per cent. Second mortgage debenture bonds, authorised issue, £100,000 less £6,180, amount drawn and cancelled. Current at July 1st, 1893 £49,000 *Less* drawn and paid off since... 2,120	46,900 0 0	
		172,300 0 0
Loans (secured by deposit of 246 first mortgage debentures, and of shares and debentures in other companies)		78,350 0 0
Creditors—		
Sundry creditors	13,970 18 11	
Debenture interest accrued ...	4,911 0 6	
Bills payable	4,478 15 2	
		23,360 14 7
Depreciation account		3,000 0 0
Profit and loss account—		
Net profit carried to appropriation account as per report		18,467 13 8
		£541,468 8 3

Assets.

Cr.	£ s. d.	£ s. d.
Properties, patents, and goodwill—		
Freehold and leasehold land and buildings at Bushbury, Wolverhampton, and Milwall; plant, machinery, tools, and patterns at works; patents and goodwill at date of transfer	303,059 19 4	
Paid for patents during year ...	1,000 0 0	
New office furniture and fittings ...	326 15 8	
		304,386 15 0
*Shares and debentures of other companies ...		147,872 6 7
Sundry debtors (after providing for bad and doubtful debts)		32,757 10 11
Bills receivable		3,036 7 6
Work and contracts in progress—cost		21,444 2 3
Stock—finished goods and materials on hand—cost		21,329 16 1
Reconstruction and preliminary expenses		1,888 2 1
Cash at bankers and in hand		8,753 7 10
		£541,468 8 3

* There is a contingent liability in respect of amounts uncalled on certain of these shares.

Société Française des Télégraphes Sous-Marins.

The traffic receipts of this company for 1893 amounted to some £29,960, as against £30,075 for 1892. Subventions and guarantees amounted to £9,236, or some £637 more than for 1892; this increase being due to an additional guarantee of traffic paid by Curaçao. Next year the company will be in receipt of another sum of £2,000 as a subvention from the Island of Guadaloupe. The directors think that considering the prolonged interruption to the Santiago de Cuba-Mole St. Nicholas section, the traffic receipts are satisfactory. They point out that the transit rate from Cuba to Europe amounts to some 40 per cent. of the total tax. With a view to altering this state of affairs, negotiations were commenced two years ago for a cable to connect the West Indies either with New York direct or *vid* Bermuda. Under government influence, these negotiations were suspended, and the Société took up the Azore's scheme, which, however, ultimately fell through. The original scheme of a cable to New York is now being actively pushed on, and it is hoped that some satisfactory result will be attained before long. Aerial Land lines have this year been established in Haiti between the following stations: Port au Prince, Anse à Veau, Aguin, Baradere, Gonaïves, Jacmel, Jérémie, les Cayes, Miragoane Petit-Goave, Port de Paix, St. Marc and Petionville, and have brought a satisfactory increase of work to the cables from Port au Prince and Cape Haïtien.

Compagnie Française du Télégraphe de Paris à New York.

An extraordinary general meeting of this company is called for September 29th next, for the purpose of considering the proposed winding-up of the company. Shareholders are reminded that a holding of 20 shares is the minimum which qualifies for a vote, and that the total shares represented by voters must be over 42,001 in order for the transactions to be valid. The Commercial Cable Company hold some 17,000 or 18,000 shares.

The City of Westminster Electrical Syndicate, Limited.—A general meeting will be held at 39, Eccleston Place, S.W., on October 17th, at 10 o'clock in the forenoon precisely, to receive the liquidator's report, showing how the winding-up of the syndicate has been conducted and its property disposed of; to hear any explanation that may be given by the liquidator, and to pass a resolution as to the disposal of the books, accounts and other documents of the syndicate.

Babcock & Wilcox, Limited.—The directors recommend dividends for the half-year ended June 30th last, at the rate of 6 per cent. per annum on the preference, and of 15 per cent. per annum on the ordinary shares.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending September 2nd, **1894, amounted to £794; week ending** September 3rd, **1893, £747; increase, £47; total receipts for half-year, 1894, £7,736; corresponding** period, **1893, £7,394; increase, £342.**

The Cuba Submarine Telegraph Company. The estimated traffic receipts for the month of August were £2,800; as compared with £2,851 in the corresponding month of last year.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of August, 1894, amounted to £1,583, against £1,670 in the corresponding period of last year.

The Great Northern Telegraph Company. The traffic receipts in August 1894, were £26,800; January 1st to August 31st, 1894, £182,200; corresponding months, 1893, £180,000; corresponding months, 1892, £175,600.

The Western and Brazilian Telegraph Company, **Limited. The receipts for the week ending** August 31st, after deducting **17 per cent. of the gross receipts payable to the London** Platino-**Brazilian Telegraph** Company, **Limited, were £2,542.**

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, August 29th.	Closing Quotation September 5th.	Business done during week ended September 5th, 1894. Highest.	Lowest.
184,500£	African Direct Teleg., Ltd., 4 % Deb.	100	...	...	...	101 —104	102 —105	103	102½
1,134,640£	Anglo-American Teleg., Ltd.	Stock	£2 12s.	£2 15s.	£2 11s.	40 — 43	41 — 44	42½	41¼
2,932,680£	Do. do. 6 % Pref.	Stock	£5 5s	£5 10s	£5 2s.	76 — 78	76 — 78	78	77
2,932,680£	Do. do. Defd.	Stock	...	...	...	7 — 7½	7⅛ — 8	8	7 9/16
130,000	Brazilian Submarine Teleg., Ltd.	10	8 % §	6½% §	6½% §	12½ — 13	12½ — 13	13	12 15/16
75,000£	Do. do. 5 %, repayable June 1906	100	...	...	...	108 —112	109 —113	112	...
44,000	Chili Telep., Ltd., Nos. 1 to 40,000	5	... §	10%‖ §	... §	1 — 2	1 — 2	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	139 —143	139 —143	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	3¼% §	2 % §	2 % §	⅛ — ¼	⅛ — ¼	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12½ — 13½	12 — 13 xd	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	19½ — 20½	19 — 20 xd	...	...
12,931	Direct Spanish Teleg., Ltd., £4 paid	5	4½%	4 %	4 %	4½ — 5	4½ — 5	...	...
6,000	Do. do. 10 % Pref.	5	10 %	10 %	10 %	9½ — 10	9½ — 10	...	...
30,000£	Do. do. 4½ % Debs. of £50, Nos. 1 to 1,600	...	...	...	...	105 —108%	105 —108%	...	...
60,710	Direct United States Cable, Ltd., 1877	20	3½% §	3½% §	...	8½ — 9½	8½ — 9½	9	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½% §	...	15⅝ — 15¾	15⅝ — 16	15⅞	15⅝
70,000	Do. 6 % Pref.	10	6 % §	6 % §	...	16½ — 17	16½ — 17	16 9/16	...
105,900£	Do. 5 % Debs., repay. August, 1899	100	...	...	...	105 —109	106 —110	109	...
1,294,100£	Do. 4 % Mort. Deb.	Stock	...	...	...	117 —120	117 —120	119½	118½
£50,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	15⅞ — 16	15⅞ — 16	16	15¾
62,700£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	...	...	...	103 —106	103 —106	...	...
222,800£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	...	...	...	103 —106	103 —106	...	...
320,000£	Do. 4 % Deb. Stock	Stock	...	...	...	115 —118	115 —118	116½	...
95,100£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	...	...	...	103 —106	103 —106	...	...
129,100£	Do. do. do. to bearer, 2,344 to 5,500	...	...	...	...	103 —106	103 —106	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 2,016, red. 1909	100	...	...	...	103 —106	103 —106	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	...	...	...	108 —111%	108 —111%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	5¼% §	4¼% §	4⅝% §	8⅜ — 9	8⅞ — 9⅛	9⅛	8⅞
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 % §	15½ — 16	15½ — 16	16	15¾
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜% §	8⅜% §	8⅜%	20½ — 21½	20½ — 21⅛	20 9/16	...
200,000£	Do. do. do. 5 % Debs.	100	...	...	...	105 —108	103 —106 xd	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	45 — 47	46 — 48	46½	46
37,548	London Platino-Brazilian Teleg., Ltd.	10	...	...	...	5 — 7	5 — 7	...	...
100,000£	Do. do. 6 % Debs.	100	...	...	...	109 —112	106 —109 xd	...	...
15,000	Monte Video Teleph. Co., Ord., 1 to 15,000	5	...	...	...	¼ — ¾	¼ — ¾	...	...
28,000	Do. do. 6 % Pref., 1 to 28,000	5	...	...	...	1 — 2	1 — 2	...	...
484,597	National Teleph., Ltd., 1 to 438,984	5	6 % §	5 % §	...	4⅜ — 5	4⅞ — 5⅛	5 1/16	4⅞
15,000	Do. 6 % Cum. 1st Pref.	10	...	...	...	14 — 15	14 — 15	14⅛	...
15,000	Do. 6 % Cum. 2nd Pref.	10	...	...	...	13½ — 14½	13½ — 14½	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 90,950	5	...	...	...	5⅛ — 5⅜	5⅛ — 5⅜	5⅜	...
925,017£	Do. 4½ % Deb. Stock Prov. Certs. ...	...	...	...	...	108 —111	108 —111	...	...
48,800	New Teleph., Ltd., 25,901 to 74,700; £4 paid	10	...	...	...	... ...	... ...	...	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	...	1/16 — ⅛	1/16 — ⅛	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	...	...	...	103 —106	104 —107	104½	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	3 — 5	3 — 5	3⅜	...
3,381	Submarine Cables Trust	Cert.	...	...	...	107 —112	107 —112	...	...
58,000	United River Plate Teleph., Ltd.	5	...	...	...	1 — 2	1½ — 2½	...	...
146,370£	Do. do. 5 % Debs.	Stock	...	...	...	85 — 95	88 — 94	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	..	...	3 — 5	3 — 5	...	...
249,900£	Do. do. do. 5 % Debs.	100	...	...	...	102 —105	100 —103 xd	...	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	2 — 3	2 — 3	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	...	...	...	100 —105	100 —105	103	...
64,242	Western and Brazilian Teleg., Ltd.	15	4 %	2½%	5 %	7 — 7⅛	7⅛ — 7⅜	7⅝	...
33,129	Do. do. do. 5 % Cum. Pref. ...	7½	...	...	...	6 — 6½	6 — 6½	...	...
33,129	Do. do. do. 5 % Def.	7½	3 %	...	...	2 — 2½	2 — 2½	...	...
178,200£	Do. do. do. 6 % Debs. "A," 1910 ...	100	...	...	...	106 —109	106 —109	...	...
222,700£	Do. 6 % Mort. Debs., series "B," red. Feb. 1910	100	...	...	...	106 —109	106 —109	...	...
88,321	West India and Panama Teleg., Ltd.	10	¼%	¼%	⅜%	1 — 1¼	1¼ — 1½	1⅜	...
34,563	Do. do. do. 6 % 1st Pref. ...	10	...	...	...	10½ — 11	10½ — 11	...	...
4,669	Do. do. do. 6 % 2nd Pref. ...	10	...	...	..	9 — 10	9 — 10	9 11/16	...
80,000£	Do. do. 5 % Debs. (1917) No. 1 to 1,000	100	...	...	...	107 —110	107 —110	...	...
$1,214,000	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	...	...	...	115 —120	115 —120	...	...
169,000£	Do. do. 6 % Ster. Bonds.	100	...	...	...	100 —104	100 —103 xd	...	...

ELECTRICITY SUPPLY COMPANIES.

20,510	Charing Cross and Strand Electy. Supply, 1 to 6, 215 to 718, and 10,001 to 30,000	5	...	5 %	4½%	4½ — 5½	4½ — 5½	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	...	...	12½ — 13½	12½ — 13½	13½	13 3/16
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	...	6 %	6 %	14 — 14½	14¼ — 14⅞	14⅝	14½
100,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	...	...	...	128 —131	129 —132	131	...
45,000	†Liverpool Electric Supply, £4 10s. paid	5	4½%	5 %	5 %	6⅝ — 6¾	6¾ — 7 xd	6 15/16	...
49,900	*Metropolitan Electric Supply, Ltd., 6,101 to 50,000 ...	10	1 %	2 %	2½%	8¼ — 8⅜	8½ — 9	9	8½
100,000£	Do. 5% Deb., 1 to 10,000 in bonds of £10, £20, £40	...	...	...	...	... — ...	... — ...	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	...	4½ — 5½	4½ — 5½	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-18,780	5	8¼%	7¼%	4½%	7 — 7½	7 — 7½	...	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8¼ — 8⅜	8¼ — 8⅜	...	...
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	...	3½%	4 %	6¼ — 6⅜	6¼ — 6¼	6 15/16	...

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, August 29th.	Closing Quotation, Sept. 5th.	Business done during week ended Sept. 5th, 1894. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	...	6 % §	6 % §	2⅜ — 3	2⅞ — 3⅛	3	2⅞
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	...	6 % §	6 % §	2¼ — 2½	2⅜ — 2⅝	2½	2¼
125,000*l*	Do. do. 4½ % Deb.	Stock	...	...	...	110 —113	109 —112 xd	111	...
630,000*l*	City and South London Railway	Stock	...	⅝%	⅝%	36 — 38	36 — 38	37½	36⅝
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	7 % §	7 % §	7 % §	1¾ — 2¼	1¾ — 2¼	...	...
50,000*l*	Do. do. 5 % 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	...	...	...	95 —100	95 —100	...	...
120,000	Electric Construction, Ltd., 1 to 120,000	2	...	...	...	½ — ¾	½ — ¾	¾	⅝
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	...	...	...	1½ — 2	1½ — 2	...	...
100,000	Elmore's French Patent Cop. Deposg., Ltd, 1 to 66,750 ...	2	*nil*	*nil*	*nil*	¼ — 3/32	¼ — 3/32	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil* ¶	*nil*	*nil*	1 — 1⅛	1⅛ — 1⅜	1⅜	1¼
67,385	Elmore's Wire Mfg., Ltd., 1 to 67,385, issued at 1 pm. ...	2	*nil*	*nil*	*nil*	⅞ — 1⅛	1 — 1¼	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	*nil* §	½ — 1½	½ — 1½	...	...
9,600*l*	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	...	...	6½ — 7½	6½ — 7½	...	...
6,837	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	5 %	5 %	7½ — 8	7½ — 8½	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	12½%	23 — 24	23½ — 24½	24	23½
200,000	Do. do. do. 4½ % Deb., 1896	100	...	...	...	103 —105	104 —106	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	...	1 %	7 1/16 — 7 1/8	7½ — 7⅝	...	...
6,295	† Do. do. Pref., £8 paid	10	...	...	...	12⅝ — 13	12¾ — 13	...	...
78,949	Swan United Electric Light, Ltd., £3½ paid	5	11 % §	10 % §	7½% §	... — ...	... — ...	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	20 %	40 — 42	40 — 42	...	...
150,000*l*	Do. do. do. 5 % Bonds, red. 1894	100	...	...	...	102 —105	102—105	...	...
54,000	Waterloo and City Railway, Nos. 1 to 54,000, £2 paid ...	10	...	...	...	2 — 2¼	2 — 2¼	2	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0% §; 1891—7% §; 1890—8% §.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5¼—5⅜.

Electric Construction Corporation, 6 % Debentures, 87—92.

Electric and General Investment, shares of £5 (£1 paid), 1⅜—2¼.

Electricity Supply Corporation, Ordinary of £5, 5—5¼.

House-to-House Company (£5 paid), 1—1½.

Do. do. 7 % Preference, of £5, 5½—5¾.

Do. do. 6 % Debentures of £100, 101—103.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 4⅜—5¼; 1st Preference Cumulative 6 %, £5 (fully paid), 6¼—6⅜.

Liverpool Electric Supply, £5 (fully paid), 6⅜—6½.

Do. do. £3 10s. paid, 4½—4⅝.

London Electric Supply Corporation, £5 Ordinary, ⅞—1⅛.

Queen Anne's Mansions Lighting and Heating Company, 6 % £100 Debentures, 101—103.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares (£4 10s. paid), 4⅛—4⅜.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

THE BRITISH ASSOCIATION.

EXPERIMENTS FOR IMPROVING THE CONSTRUCTION OF PRACTICAL STANDARDS FOR ELECTRICAL MEASUREMENTS.

Report of the Committee, consisting of Prof. Carey Foster (chairman), Lord Kelvin, Profs. Ayrton, J. Perry, W. G. Adams, and Lord Rayleigh, Drs. O. J. Lodge, John Hopkinson, and A. Muirhead, Messrs. W. H. Preece and Herbert Taylor, Prof. J. D. Everett, Prof. A. Schuster, Dr. J. A. Fleming, Profs. G. F. Fitzgerald, G. Chrystal, and J. J. Thomson, Messrs. R. T. Glazebrook (secretary), W. N. Shaw, and T. C. Fitzpatrick, Dr. J. T. Bottomley, Prof. J. Viriamu Jones, Dr. G. Johnstone Stoney, Prof. S. P. Thompson, and Mr. G. Forbes.

On a Determination of the International Ohm in Absolute Measure.

By Prof. J. V. Jones, F.R.S., Principal of the University College of South Wales and Monmouthshire, Cardiff.

(*Concluded from page* 274.)

The change of rate of rotation corresponding to a change of our division on reversal was previously determined, and hence from each set of observations the speed corresponding to the true equilibrium position could be calculated. The results are as follows, the figure in each case giving the value of the international ohm in true ohms:—

July 7th.—Standard coil carefully adjusted. Three-minute tapes.

·999703
·999761
·999806

Mean ·999757

July 9th.—No readjustment of standard coil. One-minute tapes.

·999757
·999711
·999683
·999782

Mean ·999733

July 10th (morning).—Standard coil readjusted. One-minute tapes.

·999734
·999818
·999726

Mean ·999759

July 10th (afternoon).—No readjustment of standard coil. Three-minute tapes.

·999708
·999742
·999764

Mean ·999738

July 11th (afternoon).—Standard coil readjusted. Three-minute tapes.

·999692
·999692
·999679

Mean ·999688

July 12th (morning).—No readjustment of standard coil. Resistance coils reversed.

·999713
·999711
·999692

Mean ·999705

July 12th (afternoon).—Standard coil readjusted. Resistance coils removed from the mercury cups and replaced. Three-minute tapes.

·999774
·999787
·999759

Mean ·999773

July 13th.—Standard coil readjusted. Resistance coils removed from mercury cups and replaced. Three-minute tapes.

·999847
·999809
·999782
·999842 (morning of the 14th).

Mean ·999820

July 14*th* (morning).—Standard coil readjusted. Resistance coils removed and replaced. Three-minute tapes.

·999695
·999692
·999717

Mean ·999701

July 14*th* (afternoon).—Standard coil readjusted. Resistance coils removed and replaced. Three-minute tapes.

·999853
·999866
·999875

Mean ·999865

It is clear that in the above series the chief variations are due to changes consequent on readjustment of the standard coil and the removal and replacement of the resistance coils in their mercury cups. Counting as independent only those of the observations before which there was readjustment of the standard coil or removal of the resistance coils from the mercury cups, the general mean is—·99976.

The maximum variation from the mean is ·000106, or about 1 part in 10,000.

Assuming that the international ohm is the resistance of a column or mercury at 0° of 1 square millimetre sectional area, and 106·30 cm. long, we have as a result of the above measurement that the true ohm is the resistance of a column of mercury of the same sectional area and 106·326 cm. long.

The figure I arrived at in 1890 working direct on mercury was 106·307, with a probable error of ·011. The new result is, therefore, a little larger than I was prepared for. The accuracy of the result depends primarily on:

1. The accuracy with which the resistance coils are known in terms of the international ohm.

2. The accuracy with which their temperatures are known at the times of observation.

3. The accuracy with which the coefficient of mutual induction of the coil and disc has been determined.

Upon the first point I can say little. Mr. Glazebrook knows better than anyone to what figure the values of the resistances may be relied on.

The effect of error in the estimation of the temperatures of the coils can be but slight. The observations have been made in two ways, viz., with one-minute tapes, the current being put on only during the time of observation, and with three-minute tapes, the current being kept on continuously, whether observations were being made or not. During the last few days of the observations the current was kept passing through the coils night and day. I have calculated the effect that would be produced on the result obtained with one-minute tapes if all the heat generated by the current were to remain in the coils—an extreme case, obviously less favourable than the actual conditions. It is something less than two parts in 100,000. The smallness of the effect is due to the fact that if x is the main current, a current equal to $\frac{200}{201}\,x$ passes through the tenth ohm manganine coil with its small temperature coefficient, and only $\frac{1}{201}\,x$ through the platinum-silver coils, while the effect of under-estimating the temperature of the manganin tenth ohm coil is to produce an error in the result opposite in sign to that produced by under-estimating the temperature of the platinum-silver coils.

There cannot, then, in the case of the one-minute tape observations be an appreciable error due to under-estimation of the temperature. But the first four sets of observations show that the results of the one-minute tape observations and the three-minute tape observations are practically the same. Hence it follows that to the degree of accuracy aimed at, our results are unaffected by errors due to under-estimation of the temperature.

It remains to consider the accuracy with which the coefficient of mutual induction of the coil and disc is known. To calculate this coefficient we must know the radius of the disc and the mean radius of the coil. The circumference of the disc is a sufficiently true circle, the disc having been ground true in place. The measurement of its diameter presented no difficulty. It was determined on my Whitworth measuring machine to the ten-thousandth of an inch.

The mean radius of the coil cannot be determined with the same accuracy; but I believe that it is known to the thousandth of an inch. The coil consists of a single layer of silk-covered wire, wound in a screw thread cut on a brass frame. It was measured along 18 diameters in the Whitworth machine, with the following results:—

Diameter.	Measurements.
0—180	21·0898
10—190	21·0929
20—200	21·0951
30—210	21·0933
40—220	21·0960
50—230	21·0998
60—240	21·1017
70—250	21·1026
80—260	21·1044
90—270	21·1038
100—280	21·1056
110—290	21·1041
120—300	21·1014
130—310	21·0979
140—320	21·0945
150—330	21·0924
160—340	21·0900
170—350	21·0910
Max. 21·1056	Mean 21·09757
Mm. 21·0898	t = 17° C.
·0158	

The measures clearly show that the coil is elliptical in section, the difference between the major and minor axis being about ·008 inch, or about one part in 1,300.

In considering the possible effect of this ellipticity on the result, it must be borne in mind that the formula $\text{R} = \text{M}\ n$ implies that the coil is circular. The true formula is $\text{R} = n \int_{a\,1}^{a\,0} \text{H}\, d\, a \left(\frac{a\,l}{a\,0}\right)$, where a 0 and a 1 are the distances from the centre of the disc at which the internal and external brushes are applied, and H is the magnetic force at a distance, a, from the centre when unit current is passing through the coil.

This is an unpleasant integral for an elliptical coil, and it has not yet yielded to persuasion. It is, however, satisfactory to note that as in my apparatus the brush radius makes but a small angle with the minor axis (about 15°), I am, in so far as the ellipticity of the coil affects matters at all, under-estimating the integral, and hence under-estimating the international ohm. Any correction for ellipticity hereafter calculated will make the value of the international ohm deduced from any observations nearer, and not further, from the true ohm.

It is further to be noticed that the formula $\text{R} = \text{M}\ n$ applies only if there is exact coincidence of the axes of the disc and coil. It has been customary to consider the adjustment, for centre is of secondary importance in Lorenz's method. It would be so if the formula $\text{R} = \text{M}\ n$ were applicable when the centres of coil and disc do not coincide, for a slight displacement only affects the coefficient of mutual induction to a secondary degree. But we are not concerned with the coefficient of mutual induction in this case. We are concerned with another integral, viz., $\int_{a\,0}^{a\,1} \text{H}\, d\, a$; and the adjustment for centre is, in truth, of primary importance. Special attention should, therefore, be paid to this in designing apparatus for the absolute measurement of resistance by this method.

One other point remains to be noticed in this connection, viz., the possible effect of the difference of the temperatures of the coil and disc when measured and when in use. On calculating the correction to be applied for this cause I find it negligible.

Again I would say, as I said last year, that the chief value of these observations consists in the proof they afford of the precision with which the absolute measurement of resistance may be made by this method. A well-constructed apparatus of the kind in a national laboratory—say the laboratory of the Board of Trade—will, I believe, prove to be the best ultimate standard of electrical resistance.

APPENDIX III.

Comparison of the Standard Coils used by Prof. Jones with the Standards of the Association.

By R. T. Glazebrook.

The tenth-ohm standards of manganin wire, whose value in absolute measure was determined by Prof. Jones by means of the experiments described in Appendix II., were compared with the standards of the association in the following manner: A Wheatstone's bridge was formed in which the arms were the tenth ohm to be tested, two single-ohm coils, and a 10-ohm coil. If the coils had these values exactly, there would, of course, always have been a balance; since, however, the coils were not accurately correct, there was usually a small current through the galvanometer. The balance, however, could be obtained by placing a large resistance as a shunt either to one of the 1-ohm coils or to the 10-ohm coil. This resistance, which varied from 10,000 to 20,000 ohms, was taken from a good box of coils. The resistances of the 10-ohm and of the two 1-ohm coils being known, that of the tenth-ohm coil could readily be found.

The four coils dipped into four mercury cups cut in an ebonite block; the bottoms of these cups were copper pieces some 3 mm. to 4 mm. thick. Binding screws screwed into these copper pieces, and rising above the mercury, serve to connect the bridge to the galvanometer and the battery.

The mercury cups were somewhat large, about 2·5 cm. in diameter, and it was found on January 16th that distinct differences could be observed by moving the tenth-ohm coils slightly, so as to bring their terminals either close to or as far as possible from the feet of the 1-ohm coils which dipped into the same cups. After this date these two sets of measurements were made for each coil at each observation; in the one the terminals of the coils in any cup were put as close together as possible; in the other the terminals of the ·1-ohm coils were placed at some distance from those of the other coil in the same cup.

Both sets of values are given in the table as a means of showing the delicacy of the observations and the error arising from this cause. The tenth-ohm coils were weighted so as to press firmly on to the copper bottoms. Now variation was produced by shifting the 10-ohm coil in its cup.

One or two Leclanchés were used in the various experiments; the coils were in water baths, and the temperature read by a standardised Kew thermometer.

The standard coils used were:

Elliott 264 = 1 + ·000312 (t − 15·45).
Nalder 3,715 = 1 + ·00026 (t − 14·95).
Elliott 289 = 10 + ·00260 (t − 15·4).

The results of the experiments are given in the following table. In the results of the experiments made after January 15th the two values given correspond to the two positions of the coil in the mercury cup. They are included to show the magnitude of the error which may be due to the resistance of the copper bottoms of the cup.

Table giving Values of Nalder No. 4,274, C.L.C. No. 389, in Terms of the Ohm Standards of the Association.

Date.	Temperature (deg).	Value of resistance.	
December 29th, 1893 ...	14·4	·100052	
January 13th, 1894 ...	15·2	·100051	
„ 15th, „ ...	14·8	·100056	
„ 16th, „ ...	15·5	·100051	·100056
„ 17th, „ ...	16·4	·100049	·100058
„ 27th, „ ...	16·9	·100057	·100066
February 20th, „ ...	14·1	·100036	·100041
March 17th „ ...	14·1	·100045	·100046
Mean	15·2	·100050	·100054

Values of Nalder 4,275, C.L.C. 390.

Date.	Temperature (deg).	Value of resistance.	
December 29th, 1893 ...	14·6	·100059	
January 13th, 1894 ...	15	·100053	
„ 15th, „ ...	15	·100058	
„ 16th, „ ...	15·8	·100055	·100061
„ 17th, „ ...	16·4	·100051	·100059
„ 27th, „ ...	16·6	·100058	·100065
February 20th, „ ...	14·1	·100043	·100047
March 17th „ ...	13·8	·100051	·100051
Mean	15·2	·100053	·100057

Thus the value of the coils at 152° are respectively for
C.L.C. 389, ·100050 ohm,
and for
C.L.C. 390, ·100053 ohm,
while in each case the resistance introduced by placing the contact pieces of the tenth-ohm coils at some distance from those of the other coils is ·000004 ohm.

APPENDIX IV.

Comparison of Some Standards of the Board of Trade.

I give in the accompanying table the results of comparisons which I made on May 29th and 30th, 1894, at the Cavendish Laboratory between the three unit coils.

Elliott's No. 261,
„ No. 263,
Nalder's No. 3,876.

belonging to the Electrical Department of the Board of Trade, and the B.A. standards, flat, F, G, and H.

The bridge used was of the Carey Foster pattern, constructed for the Department by Nalder Bros. & Co., and the bridge wire used was the one marked B, having a value of ·0000509 ohm per division.

A 100-obm coil, Elliott's No. 291, was placed in parallel with the Board of Trade coil for each comparison, this being effected by a large mercury-in-paraffin bath.

Temperatures were measured by a mercury-in-glass thermometer, which had been standarised at Kew.

J. Rennie.

B.A. Coil.	Temp. of B.A. coil.	Temp. of B. of T.coil.	Observed value.	Chart* value.	Difference chart observed.
No. 261 Coil.					
Flat	12·54	12·58	·999156	·999142	− ·000014
F	12·53	12·45	064	·106	+ 042
G	12·90	12·97	217	·262	+ 045
H	12·85	13·01	330	·275	− 055
No. 263 Coil.					
Flat	12·50	12·53	·999136	·999140	+ 000004
F	12·60	12·48	074	124	+ 050
G	12·80	12·98	217	271	+ 054
H	12·85	13·08	299	304	+ 005
No. 3,876 Coil.					
Flat	12·60	12·45	·998808	·99979	− ·000018
F	12·50	12·36	727	76	+ 049
G	12·70	12 23	697	74	+ 043
H	12·40	12.30	768	76	− 008

* The chart referred to, for No. 261 and No. 263 coils, is one supplied for these coils by Mr. Glazebrook, and is dated March, 1892. The chart referred to in the case of No. 3,876 was constructed from comparisons made by Nalder Bros. between it and their "master" coil, No. 3,717.—J. Rennie, June, 1894.

APPENDIX V.

Table showing values of five standard coils, B.A. units, belonging to the Indian Government, as compared with Dr. Muirhead's standard at his laboratory. Standard used, N_2 78, marked right at 15·7° C., taken as correct. This standard, tested April 27th, 1893, against a N_2 68 Glazebrook, gave a ratio $\frac{\text{coil}}{\text{standard}}$ of 1·00015 at 16° C., and 1·00018 at 15° 4 C. Temperature of water, 20·2° C.

Number.	Marked right at.	Difference.	Correct at.
106	15·1° C.	+ ·023 per cent.	14 0° C.
108	15·3° C.	+ ·126 „	11·7° C.
110	15 3° C.	− ·028 „	16·6° C.
111	15·5° C.	+ ·055 „	13 9° C.
114	15·1° C.	+ ·004 „	15·6° C.

Apparatus used—one metre bridge of platinum-iridium wire with a supplementary coil at each end of 20,012 mm.; suspended coil galvanometer, resistance 15 ohms (Muirhead & Co.'s); trough 45 inches by 7¼ inches by 5 inches, depth of water 2⅜ inches, quantity of water 6¼ gallons; battery used, one Hellesen's dry cell, N_2 3; E.M.F. 1·4 volt.

The interest attaching to these tests lies especially in the fact that the standard coils have been exposed to the climate of Calcutta for 24 years. They were made, I understand, by Dr. A. Muirhead when in Dr. Mathiessen's laboratory, under the supervision of the latter.

In reducing the observations from 20·2 to the temperatures given it has been assumed that all the coils have the same temperature coefficient.

E. O. Walker, C.I.E., M.I.E.E.,
(late Superintendent in the Government Telegraph Department in India).

APPENDIX VI.

On the Specific Resistance of Copper and of Silver.

By Rev. T. C. Fitzpatrick.

As lately several observers have published the results of measurements made on the specific resistance of copper, it may be worth while to collect these results together in tabular form.

The resistance of metals may be expressed in terms of equal weight or of equal volume—that is, as the resistance of a wire of the given material and that one metre of it weighs one gramme, or as the resistance between opposite faces of a cube of the material, each face of which is one square centimetre.

I have pointed out that Matthiessen* considered the first as the most satisfactory mode of expressing resistances, and for these results alone did he make all the actual experiments. The results for specific resistances were calculated from these, with the help of specific gravity values obtained in many cases from tables, and not determined directly for the wires used.

Only in the cases where considerable masses of the material are used can the specific gravity from the cross-section of the wires be accurately determined. There is therefore an evident advantage in expressing results in terms of weight when the determination of the cross-section of the wires becomes unnecessary, and there is no reason why an accuracy of one in two or three thousand should not be attained.

Again, it is found that different samples of copper have different densities, according to the method by which they have been prepared. In a table* which I published on a previous occasion, the variation is from 8·86 to 8·95. Mr. Swan† gives a value as high as 8·9587.

From samples of copper of the same quality I have had wires drawn which differed in density. It was always found that the denser the copper the less is its resistance, and the difference affects much more the results expressed as specific resistances than when expressed as the resistance of a gramme per metre.

This is another reason for expressing the results with these terms, at least as well as in specific resistances, and for actual practical purposes it is a question of weight rather than volume.

In the following tables the results are given for and temperature of 18° C. in C.G.S. units:

Table A.—Hard Drawn Copper Wires.

Resistance of wire such that one metre weighs one gramme.	Specific resistance per cubic centimetre.	Observer.
1,550 × 10⁵	1,743	Matthiessen.*
—	1,720	Swan and Rhodin.†
1,550	1,726	Fitzpatrick.‡
1,527	1,708	„ (copper supplied by Messrs. Bolton).

Table B.—Annealed Wires.

Resistance of wire such that one metre weighs one gramme.	Specific resistance per cubic centimetre.	Observer.
1,516	1,704	Matthiessen.
—	1,681	Fleming and Dewar.§
—	1,680	Swan and Rhodin.
1,488 × 10⁵	1,665	Fitzpatrick (copper supplied by Messrs. Bolton).
1,488	—	(Wire sent by Mr. Swan).

* B.A. Report, 1864. † *Nature*, Vol. v., p. 165. ‡ B.A. Report, 1890, p. 125. § *Phil. Mag.*, Vol. xxxvi., p. 287.

* B.A. Report, 1890, p. 129; *ibid*, p. 125.
† *Nature*, vol l., p. 165.

From Table A, it will be seen that Messrs. Swan and Rhodin obtained a value rather lower than that which I got for copper which I had prepared myself, and which expressed as the resistance of a wire one metre long weighing one gramme is identical with the value that Matthiessen obtained; but the resistance of all these specimens is distinctly greater than those of the copper kindly sent me by Messrs. Bolton, which seems to bear out the statement which I have previously made that it is impossible to prepare wires on the small scale which are of the same quality—*i.e.*, probably due to density—as the best specimens specially prepared by large manufacturers.

In Table B are given the results of measurements with three specimens of copper prepared by Mr. Swan. One was given to Messrs. Dewar and Fleming, a second was examined by Mr. Swan himself, and a third specimen he kindly sent to me; the quality of the copper in the three cases may therefore be expected to be the same.

The results of Messrs. Dewar and Fleming and Messrs. Swan and Rhodin are expressed only as specific resistances, whilst the result of my measurements is only given for a wire one metre long weighing one gramme. The weight of the copper wire, as measured, was only three grammes, and that does not allow the accurate determination of the specific gravity of the sample; the value I obtain for it is identical with that for the sample of annealed copper wire sent me by Messrs. Bolton.

If I consider it to have the same specific gravity as that sample (8·94), I get as its specific resistance in C.G.S. units, 1,665, a value distinctly smaller than that obtained by Messrs. Swan and Rhodin, whose result is practically identical with that of Messrs. Dewar and Fleming.

Not only may wires drawn from the same specimen of copper have different densities and different resistances, but the variation of that resistance with change of temperature is also different.

In the following table are given the temperature coefficients of various specimens of copper:—

$$R_t = R_0 (1 + a\,t).$$

R_0.	a.	Observer.
—	·00387	Matthiessen.†
1,561	·00428	Dewar and Fleming.‡
1,603*	·00408	Swan and Rhodin.§
1,563	·00417	—
1,592*	·00405	Fitzpatrick.
—	·00406	Kennedy & Fessenden.‖
—	·00364	Benoit.¶

* Hard-drawn wires. † B.A. Report, 1864. ‡ *Phil. Mag.*, Vol. xxxvi., p. 287. § *Nature*, Vol. l., p. 165. ‖ *Electricity*, Vol. v., p. 165. ¶ *Comptes Rendus*, Vol. lxxvi., p. 345.

Influence of Annealing.—As is well known, annealed wires have a less resistance than hard-drawn wires; but the variation of resistance according as the wires are annealed or hard-drawn, differs considerably for different materials. For silver it is as much as 10 per cent., whereas for copper it is less than 3 per cent.

I have made observations from time to time on the resistance value of specimens of hard-drawn copper wire, all pieces of the same coil, which was sent me in 1889 by Messrs. Bolton & Son. Given the results of these measurements, it will be seen that a hard-drawn wire seems to fall in resistance with lapse of time; the coil of wire has been left laying in the laboratory, and has not been treated with any special care:—

Date.	Temperature.	Resistance of wire 1 metre long, weighing 1 gramme.
July, 1890	18°	1,528 × 10^5
August 26th, 1891	18°	1,525
March 7th, 1892	18°	1,522
January, 1894	18°	1,520
July, 1894	18°	1,519

The fall in resistance is small, and for the period of nearly five years does not amount to more than one-third per cent. I have, for the sake of comparison, made a measurement of the resistance of a specimen of annealed copper wire sent me by the same firm, and for this the resistance value is identical with that obtained at a previous date.

Date.	Temperature.	Resistance of wire 1 metre long, weighing 1 gramme.
October, 1889	18°	1,488 × 10^5
July, 1894	18°	1,487 8

This, on the whole, is what one would expect. In the case of wires of other material the change would probably be greater, as the difference of resistance between annealed and hard-drawn copper wires is less than that for wires of other materials.

To my previous communication a method* of annealing was described which gave satisfactory results; the wire was packed in asbestos or fine carbon in a copper vessel, and heated for 24 hours.

The following results, amongst others, were obtained:—

Hard-drawn, at 18°.	Annealed. 18°.	Difference.
1,527 × 10	1,489	·39
1,526	1,488	·38

* B.A. Report, 1890, p. 126.

Matthiessen's values are:—

1,550 ..... — ..... —

Messrs. Swan & Rhodin give for the values of the specific resistances:—

1,720 ..... 1,680 ..... ·40

I have recently been annealing copper wires by heating them in boiling paraffin (220°), and at this temperature, after slow cooling, the wires seem to be completely annealed.

1,526 ..... 1,486 ..... ·40

A wire sent me as annealed gave the result:—

— ..... 1,488 ..... —

This wire was then hardened and reannealed, and gave the above-described value:—

— ..... 1,489 ..... —

Either of these two methods seemed to give satisfactory results. But for annealing silver wires completely the temperature of the paraffin bath is not sufficiently high, but from the results of my measurements for silver, for which the influence of annealing is very considerable, it could be seen that the results given for the first method are very consistent.

Silver.

Many of the older measurements for resistances and conductivities are expressed in terms of the resistance of pure silver. This was the case with Matthiessen's earlier results. Some measurements, therefore, made on silver wires are given, together with the results obtained by Matthiessen and Messrs. Dewar and Fleming for the sake of comparison.

Several samples of silver wires were supplied me by Messrs. Johnson and Matthey. One of these was stated to be absolutely pure. The results are expressed for wires weighing 1 gramme per metre.

	Hard-drawn.	Annealed.
Silver I.	(*a*) 1,816 × 10^5	1,739 × 10^5
	(*b*) 1,814	1,741
	(*c*) 1,816	1,721
Silver II.	1,799	1,722
Silver III. pure	(*a*) 1,777	1,666
	(*b*) 1,773	1,666
	(*c*) 1,767	—

The difference between the values for the hard-drawn wires is probably due to the fact that they had to be further drawn down after I had received them to enable me to measure them on bridge.

Matthiessen's values.	For wire 1 metre long weighing 1 gramme.	R. per c. cm.
Hard-drawn	1,779 × 10^5	1,694*
Annealed	1,639	1,561

* Using the value 10·5 as the specific gravity of silver.

Messrs. Dewar* and Fleming give as the value for an annealed pure silver wire, 1,468 C.G.S. at 0° C., with the temperature coefficient of ·004; the value at 18° is, therefore, for the specific resistance, 1,574.

For most of the wires which I measured I determined the specific gravity. For the wires silver I. there is practically no difference between the values obtained for the annealed hard-drawn wires, the values varying from 10·496 to 10·511.

For the wires silver III. the values varied from 10·49 to 10·50; using the mean value, 10·495, I get for the specific resistances the following values:—

	Hard-drawn wire.	Annealed.
Specific resistance in C.G.S. units at 18°	1,689	1,587

In the case of copper,† with increase of purity, there is a decrease in the difference in resistance between annealed and hard-drawn wires. With silver the reverse is the case.

Silver	I. Difference	75
	II. „	77
	III. „	107

The value that I obtained for the hard-drawn wire is very nearly the same as that given by Matthiessen, but he obtained a greater decrease in resistance on annealing. He states‡ that for different pieces of the same wire there was a variation of from 6 per cent. to 10 per cent., so that the difference between his value and that which I have obtained for the sample of pure silver is not greater than might be expected.

The considerable variations in all the values given above make it clear that the values of the specific resistance depends not simply on the purity of the material, but on a number of other factors, which will be different in the cases of different wires of the same material, and that, therefore, we cannot expect to attain to any great degree of accuracy in the determination of specific resistances.

SELECTING A STEAM BOILER.

WRITING to our American contemporary, *Electrical Engineering*, Mr. Jas. H. Harris does not add much to the subject, but he does call attention to the neglect of architects to make proper provision for the housing of the boiler or boilers in buildings they design, whereby it happens that either a place must be made, or the boiler must be crammed into a space quite inadequate to suitably contain it. The worst place for a boiler is, obviously, below the saturation level, or so low that the brick seatings become damp by capillary action, and the necessity

* *Phil. Mag.*, Vol. xxxvi.
† B.A. Report, 1890, p. 196.
‡ *Phil. Trans.*, 1862, p. 7.

cannot be too strongly insisted upon of securing an impervious floor of concrete upon which to build a boiler setting. Apparently articles of great weight, steam boilers are not so enormously heavy per square foot of floor space occupied even when their brick seatings are included, and where an upper floor can be found for them, we fail to see any serious objection to the placing of them otherwise than on the lowest floor.

Where placed on a floor, the space beneath is not necessarily lost. The increased safety thus secured through the immunity from corrosion is worth something. On this subject of setting boilers the next article deals. It is a reprint of a paper by Mr. McMynn, read at the meeting of the North Western Electrical Association on July 18th at St. Paul. He condemns, and our own experience would lead us to do the same, the entrusting of the setting of a boiler to the local bricklayer who "has set hundreds," and is setting them to-day as he did ten years ago, whereas a better setting with at least 6 inches space between shell and sidewalls may save 15 per cent. This may be compared with the minimum of 9 inches, recommended by the English Boiler Insurance Companies for this same side space.

Our author considers that a boiler house should always be furnished with a calorimeter to test the quality of the steam, thermometers to test the feed temperature, and asks "How many of you know exactly what it costs you to evaporate your water and can distribute your station expenses?" But he has heard of a new plant in process of construction that is to have a pair of 10-ton bunkers on scales in which to weigh out coal, and a water meter to show the feed, so that any time the exact weight of fuel used and water evaporated can be told, though for more accurate testing he would measure feed water in tanks, so that the quality of a coal can be known exactly, and the purchasing agent advised accordingly.

He would also raise the standard of the fire-room by paying good men better wages and not imagine that any man can shovel coal into a boiler furnace well enough for steam raising. This we have always insisted upon, as we do not believe in the possibility, that has been claimed, of covering firemen's mistakes by adding heating surface. A formula is given by which, apart from safety, it may be determined what boiler will prove least expensive. We do not lay great value on these formulæ, but give this one for what it may be worth.

Let B = cost of boilers.
b = rate of interest on ditto.
P = cost of plant exclusive of boilers.
p = equal rate of interest on P.
A = cost of attendance per horse-power.
C = cost of compounds and incidentals per H.P.
D = cost of repairs.
N = horse-power.
T = number of hours run per year.
W = cost of fuel burned per horse-power.

Thus, total cost per H.P. hour will be

$$\frac{\left(\mathrm{B}+\mathrm{B}\frac{b}{100}\right)+\left(\mathrm{P}+\mathrm{P}\frac{p}{100}\right)+\mathrm{NAT}+\mathrm{CNT}+\mathrm{D}+\mathrm{WNT}}{\mathrm{NT}}$$

applying which to each particular location gives the economy, and it is stated that, generally speaking, it is economy to enlarge a plant to burn cheaper fuel, the limit being reached when the interest on the investment equals the annual saving.

Mr. McMynn looks upon water tube boilers as safer than the ordinary boilers (? of shell type). This is hardly to be wondered at, seeing that American practice allows working pressures on shell boilers far in excess of what we consider proper. Indeed, a single riveted shell is allowed what is here given as suitable for double riveting.

NEW PATENTS—1894.

15,789. "Improvements in thermo dynamic motors." F. W. Crossley and J. Atkinson. Dated August 20th.

15,816. "Improvements in or relating to automatic telegraph apparatus for indicating the direction and speed motion of marine or other engines." P. Douglas. Dated August 20th.

15,825. "Improvements in constructing electric cartridges for fog signalling on railways." H. Brocklehurst and H. Constien. Dated August 20th.

15,843. "An improved telegraphic apparatus for transmitting domestic orders or other signals." L. Boudet and P. Lacombe. Dated August 20th.

15,858. "Improvements in permanent ways for electric railway and tramway vehicles." J. Claret and O. Wuilleumier. Dated August 20th.

15,899. "An improvement in copper castings for electrical purposes." Siemens Bros. & Co., Ltd. (Communicated by E. Obach, Germany.) Dated August 21st.

15,900. "Improved means for preventing variations in the regulation of shunt arc lamps for alternating currents." Siemens Bros. and Co., Ltd. (Communicated by Messrs. Siemens & Halske, Germany). Dated August 21st. (*Complete.*)

15,914. "An improved manufacture of artificial India-rubber, gutta-percha, and leather, suitable for conversion into varnish." A. V. Newton. (Communicated by A. Nobel, France.) Dated August 21st.

15,920. "Improvements in and connected with primary batteries." G. H. Reid. Dated August 21st.

15,921. "Improvements in the electrical propulsion of boats and vessels." A. G. New and A. J. Mayne. Dated August 21st.

15,949. "An instrument for acquiring the art of telegraphy." J. Cocking. Dated August 22nd.

15,978. "Improvements in electro-medical appliances." A. I. Grabham. Dated August 22nd.

15,985. "Improvements in or connected with electric arc lamps." W. H. Akester and H. H. Price. Dated August 22nd.

16,002. "Improvements in apparatus for refining metal by electrolysis." H. A. House, H. A. House, jun., and R. R. Symon. Dated August 22nd. (*Complete.*)

16,097. "Improvements in and relating to electric high and low tension fuse heads for use in blasting." T. Malson. Dated August 23rd.

16,100. "Improvements in apparatus for use in the electrolysis of alkaline chlorides and other alkaline salts." H. Auer and F. Hurter. Dated August 23rd.

16,105. "Improvements connected with the electrical deposition of zinc and other metals." R. Heathfield and W. S. Rawson. Dated August 23rd.

16,106. "Improvements in galvanometers." A. Ford-Lloyd. Dated August 24th.

16,112. "An adjustable electric contact specially designed for safe and strong-room doors." F. C. Geary. Dated August 24th.

16,131. "Improvements in electric signs and advertisements." W. D. Hawksey and I. M. Lamb. Dated August 24th.

16,145. "Improvements in electrolytic processes and apparatus." C. Hessel. Dated August 24th.

16,156. "Improvements in and relating to electric winding engines, locomotives, and other electric motors, chiefly designed for use in mines." B. Lebrun. Dated August 24th.

16,162. "Improvements in accumulators or secondary batteries." M. Engel. Dated August 24th.

16,163. "Electrical apparatus for controlling the motion of cranes, travellers, and other similar apparatus." J. A. Essberger and A. W. Geyer, both of the firm Union Electricitats Gesellschaft. Dated August 24th.

16,173. "Improvements in the method of and apparatus for obtaining metallic zinc from zinc ores." F. L. Lesage and A. F. Breuillaud. Dated August 24th.

16,191. "Improvements in or relating to electric bells and other sounding or indicating devices." S. Quincey, P. Benns, and H. Belham. Dated August 24th.

16,192. "Improvements in or relating to electric bells and other sounding or indicating devices." S. Quincey. Dated August 24th.

16,230. "Improvements in heating and igniting devices for gas engines." A. Saurer-Hauser. Dated August 24th.

16,243. "Improvements in the electric propulsion of cars." A. H. Brintnell. Dated August 25th. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1893.

4,106. "A process for maintaining positive plates of secondary voltaic batteries in good operative condition." L. Epstein. Dated February 24th. The inventor first drys the plates which have their coating soft, and then reduces the oxide by a negative current, and re-oxidates by a positive current. 2 claims.

10,398. "Improvements in effecting electrical communication with vessels or buoys at sea." G. C. L. Lenox. Dated May 26th. The electrical cable is brought to a central buoy or vessel unencumbered with moorings, but attached to two or more buoys which carry the moorings. Each of these buoys is anchored by two chains extending to an angle of at least 45° apart. To retain the central buoy or vessel which supports the electric cable in a fixed position at all times of the tide, extra weights may be suspended to the attachments between it and the mooring buoys. These as the tide ebbs and flows control any slackness in the attachments which might otherwise cause them to foul the moorings.

11,168. "Improvements in arc lamps." B. Death. Dated June 7th. Has for its object to provide a lamp with two or more rods, having racks and carrying the carbons, which are alternately automatically brought into operation through the action of the racked rods acting upon a train of clockwork mechanism. 2 claims.

11,294. "Improvements in automatic electric exchanges." R. Pippette. Dated June 8th. Relates to the application to electric exchanges for any purpose, but especially with regard to telephony, of the apparatus described in patent No. 16,768, 1892.

12,362. "Apparatus for the marking of meat by electricity, and other analogous purposes." M. F. Armstrong, J. Kincaid, J. E. Waller and E. Manville. Dated June 23rd. A rod or wire of platinum or other suitable material is raised to a suitable temperature by the passage of an electric current through it, and can be so used that it may burn through the skin covering the meat without injuring the meat underneath. 3 claims.

12,523. "Improvements in or connected with brushes or other appliances for the curative application of electricity." C. J. Wollaston. Dated June 26th. The inventor provides wires or other conductors of electricity which are so arranged in a suitable support holder or backing that the ends or portions of the length thereof can be brought into contact with the body. 6 claims.